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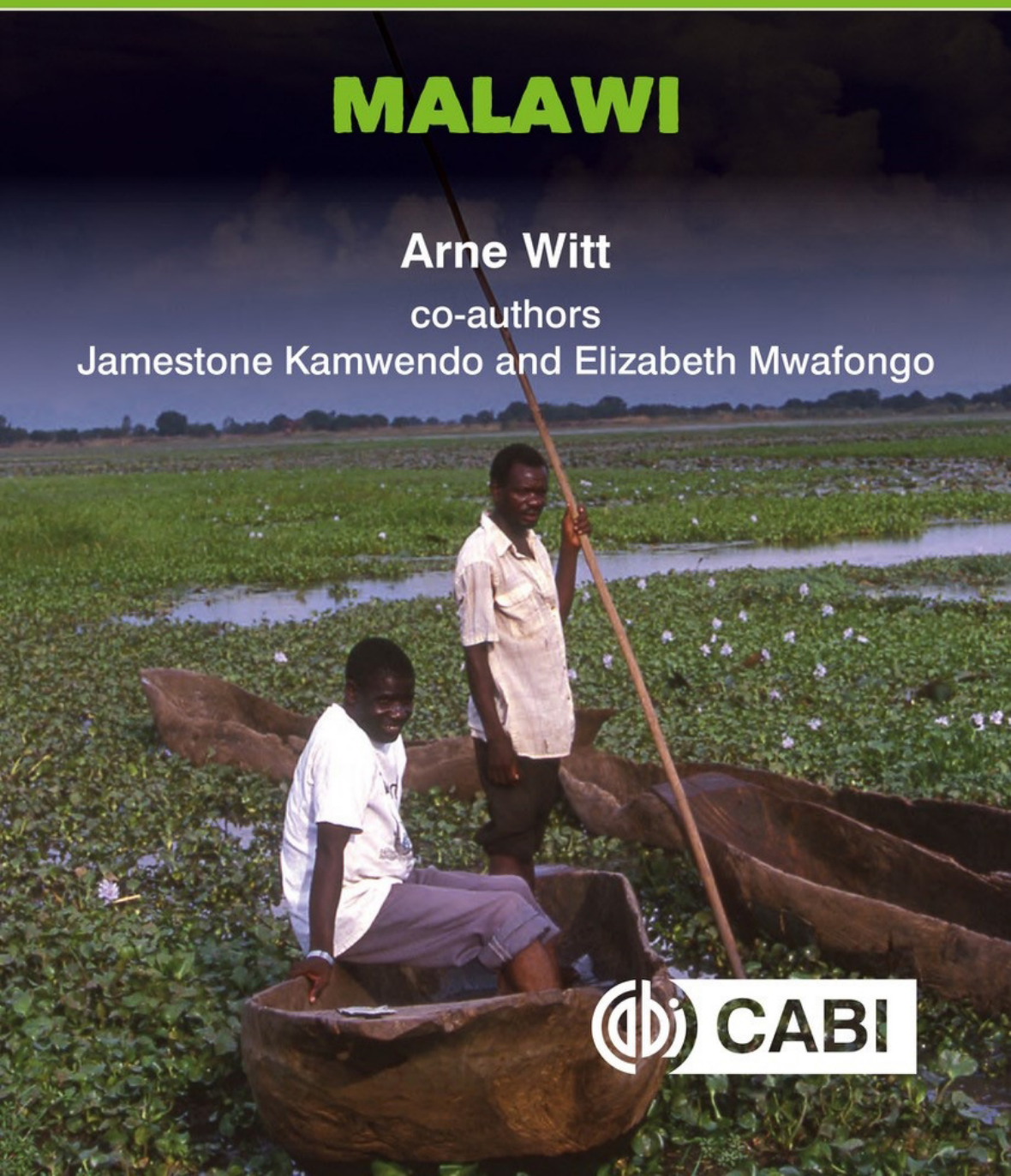
GUIDE TO THE NATURALIZED AND INVASIVE PLANTS OF

MALAWI

Arne Witt

co-authors

Jamestone Kamwendo and Elizabeth Mwafongo



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MALAWI

Arne Witt, CABI

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First published in 2024

The Global Environment Facility (GEF)-funded project **Enhancing sustainability of Protected Area systems in Malawi and stabilizing agro-production in adjoining areas through improved IAS management**, is implemented by the United Nations Environment Programme (UNEP), and executed by the Environmental Affairs Department of the Government of Malawi.

This publication was funded/co-funded by the Global Environment Facility. Its contents are the sole responsibility of Arne Witt, his co-authors and CABI, and do not necessarily reflect the views of the GEF Secretariat.

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A catalogue record for this book is available from the British Library, London, UK.

ISBN-13: 9781800622241 (ePDF)
9781800622258 (ePub)
DOI: 10.1079/9781800622258.0000

Design: Sarah Hilliar, CABI

Typesetting: TNQ Technologies

Maps: Tim Beale

Line drawings: Elijah Njoroge

Front cover image: Roger Day, CABI

Printed and bound by UNEP Publishing Unit, Nairobi, Kenya

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Arne Witt is currently the Regional (Africa and Asia) Coordinator for Invasive Species for CABI, based in Wilderness (George), South Africa. He has been an International Project Coordinator and/or Technical Advisor for a number of regional and national UNEP-GEF IAS Projects in Africa, Asia, Caribbean and the Middle East. In these roles he has worked with countries in developing policies, building capacity, creating awareness, and developing and implementing best management practices, including biological control. He continues to develop and implement IAS projects in these regions.

Arne has a PhD from the University of the Witwatersrand, South Africa. He has Master of Science degrees in Entomology (Stellenbosch University) and Conservation Biology (University of Cape Town). He has published a number of journal articles, and authored or co-authored book chapters and books on the identification and management of invasive alien species.



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Foreword

Malawi has diverse ecosystems providing habitats to a large number of plant and animal species, many of them found nowhere else on earth. Biodiversity hotspots include Lake Malawi, which is home to over 700 endemic cichlid species; Mount Mulanje, which boasts 69 endemic plant species; and the Nyika plateau, which harbours over 200 orchid species. Malawi is also home to many iconic species such as elephants, lions, leopards, rhinos, and cheetah. However, this boundless biodiversity is threatened by a myriad of factors, including invasive alien species (IAS).

The impacts of some of these IAS are very well known, and include notorious pests like the tomato leafminer (*Tuta absoluta* Meyrick; Gelechiidae); fall armyworm [*Spodoptera frugiperda* (Smith); Noctuidae]; and papaya mealybug (*Paracoccus marginatus* Williams & Granara de Willink; Pseudococcidae). The impacts of introduced and invasive plants such as water hyacinth (*Pontederia crassipes* Mart.; Pontederiaceae) are also well known but very little is known about the myriad of other introduced plants which have escaped cultivation and are now impacting negatively on the goods and services provided by ecosystems on which the people of Malawi largely depend.

Strategies to manage invasive alien plants can only be developed and implemented once the presence, distribution, and impacts of these plants is known. To that end it was agreed to develop a Field Guide to the naturalized and invasive plants of Malawi with financial support from the Global Environment Facility (GEF). This Guide, which was developed by CABI, in collaboration with the Environmental Affairs Department and Malawi Herbarium and Botanic Garden, covers over 100 species, and includes detailed species descriptions, complete with line drawings, colour images and distribution maps, as well as information on impacts and on methods of control, all of which will significantly enhance our understanding of, and ability to manage, invasive plant species in Malawi. Considering the transboundary nature of IAS, the Field Guide also provides information on the distributions of invasive alien plants in neighbouring countries, specifically Zambia, which shares many transboundary conservation areas with Malawi. The Field Guide will also contribute significantly to increasing awareness and building capacity about the threat that these species pose to sustainable development. It will also contribute to Malawi meeting its obligations under various international agreements and treaties, such as the Convention on Biological Diversity (CBD) and the International Plant Protection Convention (IPPC). Improved management of invasive plants will also contribute significantly to Malawi achieving its Sustainable Development Goals.

There is no doubt in my mind that this Field Guide will contribute significantly to our understanding and management of invasive alien plants in Malawi. I thank all of the contributors and donors who made this possible.



Yusuf M. Mkungula, PhD
Secretary for Natural Resources and Climate Change

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Executive Summary

Invasive alien species (IAS) pose a serious threat to biodiversity, livelihoods and economic development in Malawi and neighbouring Zambia. Yet the management of invasive species in both countries, and of invasive alien plant species in particular, is constrained by a number of factors. Common constraints include weak policies or poor implementation of policies pertaining to IAS management; lack of awareness and of access to critical information, particularly on the presence, distribution, impacts and management of IAS; inedaquate resouces available for effective prevention and control; and a general lack of capacity.

While this situation has improved over the past 10–20 years, further progress has been hampered by the absence, hitherto, of a comprehensive invasive alien plant database for Malawi and Zambia. Attempts were made to develop one for Zambia during the UNEP-GEF Project, "Removing barriers to invasive plant management in Africa" but it was only partially completed, and activities to gather additional information not sustained. Both countries have repeatedly expressed the need for a comprehensive database, as a tool to assist in the identification of naturalized and invasive alien plant species, and in understanding their impacts, both existing and potential, while also providing pointers on what can be done to manage such species.

This information is seen as essential, not only in enabling countries to develop effective IAS management strategies, but also in helping them to meet their obligations under various international agreements and treaties, including Article 8 (h) of the Convention on Biological Diversity (CBD) which states that, "Each contracting Party shall, as far as possible and as appropriate, prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species." Without information on the presence and distributon of alien species it is obviously not possible to prioritize species for control interventions. Without effective IAS management, many of the goals agreed to under these and other protocols, such as the 2030 Sustainable Development Goals (SDG), will remain elusive. In fact, many of the SDGs will not be achieved unless IAS are effectively managed because they also, among others, impact on food and water security, and human and animal health. In fact, some invasive alien plants may exacerbate the presence and abundance of mosquitoes, vectors of a host of diseases, including the biggest killer on the continent, malaria.

In providing such a database, this Guide is intended to give Malawi and Zambia the information they require, in order to be able to develop effective strategies for combating the existing and rapidly increasing menace posed by invasive alien plants. It is further hoped that this Guide will foster increased collaboration between Malawi and Zambia, and possibly also other countries in the region, especially in responding to the challenges of managing shared invasive plant species. As such it is hoped that the Guide will contribute to increased collaboration across all of the SADC region. In fact, the SADC Secretariat has highlighted the significant threat that IAS pose to economic development in the region.

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The Guide is based on the findings of extensive roadside surveys, carried out throughout the two countries, but more so in Malawi, and on a review of the literature pertaining to naturalization and/or invasiveness among alien plants in both countries. These surveys revealed that the majority of invasive plants have been intentionally introduced, and have subsequently escaped from cultivation, establishing populations in the 'wild', to the detriment of natural resources and the millions of people in both countries who depend on these resources.

Included in the Guide are descriptions of roughly 115 exotic, non-native or alien plant species (some may have an uncertain origin) which are either naturalized or invasive already or which are deemed to have the potential to become invasive in Malawi and/or Zambia. The profiled species include two invasive grass species; two invasive fern species, one of which is native; aquatic invasive plants or waterweeds (5 species); vines, creepers or climbers (11 species); terrestrial herbs, shrubs, and succulents (more than 65 species of each), and trees (more than 25 species). This selection is undoubtedly an underestimate, given that many regions of Malawi and Zambia were not adequately surveyed, especially in Zambia. At the very least, though, we are confident that all the most widespread and abundant invasive alien plant species present in Malawi and Zambia, and a number of emerging species too, are covered in the Guide.

Malawi and Zambia share many invasive alien plant species. This can largely be attributed to the fact that most of both countries, according to the Köppen-Geiger Climate Classification, experience a humid subtropical climate with a dry winter. Significant parts of Angola, Madagascar and South Africa have a similar climate, and as such are likely to share many of the same weeds. However, Malawi ranges in altitude from about 60 m above sea level (ASL) to over 3,000 m ASL on Mount Mulanje, compared to an average altitude of 1,200 ASL (range of 1,000 to 1,600 m) in Zambia. These altitudinal differences influence temperature and rainfall, which means that Malawi is likely to provide suitable habitats for a wider variety of invasive plants than its neighbour Zambia, despite the latter being considerably larger. Both countries are also dominated by Miombo woodlands, which are also prevalent throughout much of Angola, Mozambique, Tanzania and Zimbabwe. The Southern Miombo Woodland ecoregion is known for its nutrient-poor soils, another factor which will largely influence the presence of invasive alien plants.

Some of the most problematic invasive plant species in Malawi and Zambia include lantana (*Lantana camara* L.; Verbenaceae); leucaena [*Leucaena leucocephala* (Lam.) de Wit; Fabaceae]; Chinese mint [*Hyptis suaveolens* (L.) Poit.; Lamiaceae]; Mexican sunflower [*Tithonia diversifolia* (Hemsl.) A. Gray; Asteraceae]; red sunflower [*T. rotundifolia* (Mill.) S.F. Blake; Asteraceae]; castor-oil plant (*Ricinus communis* L.; Euphorbiaceae); Australian pest pear [*Opuntia stricta* (Haw.) Haw; Cactaceae] (only Malawi); giant sensitive plant (*Mimosa pigra* L.; Fabaceae); creeping sensitive plant (*M. diplotricha* Sauvalle; Fabaceae) (only Malawi); mesquite [*Prosopis juliflora* (Sw.) DC.; Fabaceae] (only Malawi); and water hyacinth (*Pontederia crassipes* Mart.; Pontederiaceae). Other widespread and abundant species include goatweed (*Ageratum conyzoides* L.: Asteraceae); a number of species in the genus

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Senna (Fabaceae); apple of Sodom [*Calotropis procera* (Aiton) Dryand; Apocynaceae]; large cocklebur (*Xanthium strumarium* L.; Asteraceae); Spanish clover [*Desmodium uncinatum* (Jacq.) DC.; Fabaceae] (especially in Malawi); guava (*Psidium guajava* L.; Myrtaceae); and bellyache bush (*Jatropha gossypiifolia* L.; Euphorbiaceae) (mainly Malawi). Bracken fern [*Pteridium aqualinum* (L.) Kuhn; Dennstaedtiaceae], a native cosmopolitan species, is also considered by many to be troublesome, affecting crop and pasture production, and plant diversity.

Many plant species currently have a very localized distribution but have the potential, based on research undertaken elsewhere, including eco-climatic models, to possibly become considerably more widespread and problematic in both, or either one of the two countries. Such species include balloon vine (*Cardiospermum grandiflorum* Sw.; Sapindaceae) (mainly Malawi); Madeira vine [*Anredera cordifolia* (Ten.) Steenis; Basselaceae] (mainly Malawi); [*Tithonia tubaeformis* (Jacq) Cass.; Asteraceae] (only Zambia); bush morning glory [*Ipomoea carnea* Jacq. ssp. *fistulosa* (Mart. Ex Choisy) D.F. Austin; Convolvulaceae] (mainly Zambia); Mexican morning glory (*Ipomoea tricolor* Cav.; Convolvulaceae); black wattle (*Acacia mearnsii* De Wild.; Fabaceae) (only Malawi); Mexican pine (*Pinus patula* Schiede ex Schltdl. & Cham.; Pinaceae) (only Malawi); Mauritius thorn [*Caesalpinia decapetala* (Roth) Alston; Fabaceae]; and yellow bells [*Tecoma stans* (L.) Juss ex Kunth; Fabaceae], among others. Countries in brackets denote where the species are currently invasive.

Semi-arid districts in the south of Malawi are invaded by mesquite, Australian pest pear, bellyache bush, and apple of sodom. *Agave* species are also present in drier areas, where they are mostly used as living fences, as is the case elsewhere in Malawi and Zambia. Some *Bryophyllum* species, which are well-adapted to surviving in semi-arid areas, are not more abundant in the south of Malawi than elsewhere. In contrast, the higher-lying areas in Malawi, which are cooler and experience higher rainfall, are invaded by Mexican pine, golden Himalayan raspberry (*Rubus ellipticus* Sm.; Rosaceae); Ceylon raspberry (*R. niveus* Thunb.; Rosaceae); black wattle and in some areas also *Eucalyptus* species (Myrtaceae). Emerging weeds in these high lying areas, such as Nyika and Mulanje, include narrow-leaf firethorn [*Pyracantha angustifolia* (Franch.) Schneid.; Rosaceae]; Mexican hawthorn (*Crateagus mexicana* Moc. & Sessé ex DC.; Rosaceae); tree dahlia (*Dahlia imperialis* Roezl ex Ortgies; Asteraceae); common foxglove (*Digitalis purpurea* L. Plantaginaceae); and Spanish clover.

Invasive plants with no specific habitat requirements that seem to thrive in highly disturbed areas such as roadsides, overgrazed pasture, croplands, and dry river beds include various *Datura* species, especially common thorn apple (*Datura stramonium* L.; Solanaceae); goatweed; *Argemone* spp. (Papaveraceae); white spot-flower [*Acmella radicans* (Jacq.) R.K. Jansen; Asteraceae]; large cocklebur; coffee weed [*Senna obtusifolia* (L.) H.S. Irwin & Barneby; Fabaceae]; ant bush [*S. occidentalis* (L.) Link; Fabaceae]; and Congo jute (*Urena lobata* L.; Malvaceae). Other species seem to be predominantly associated with human habitation and include *Agave* spp.

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(Agavaceae); Mauritius hemp [*Furcraea foetida* (L.) Haw.; Agavaceae]; guava; rosy periwinkle [*Catharanthus roseus* (L.) G. Don; Apocynaceae]; yellow cassia [*Senna siamea* (Lam.) H.S. Irwin & Barneby; Fabaceae]; candle bush [*S. alata* (L.) Roxb.; Fabaceae]; four o'clock flower (*Mirabilis jalapa* L.; Nyctaginaceae); *Canna* spp. (Cannaceae); garden cosmos (*Cosmos bipinnatus* Cav.; Asteraceae); sulphur cosmos (*C. sulphureus* Cav.; Asteraceae); common zinnia (*Zinna elegans* Jacq.; Asteraceae); sweet prickly pear [*Opuntia ficus-indica* (L.) Mill.; Cactaceae]; Mauritius thorn; *Tradescantia* spp. (Commelinaceae); *Bryophyllum* spp. (Crassulaceae); moon flower [*Brugmansia suaveolens* (Humb. & Bonpl, ex Willd.) Bercht. & J. Presl.; Solanaceae]; and sponge gourd (*Luffa cylindrica* (L.) N. Roem.Mill.; Cucurbitaceae).

Water bodies and associated riparian zones in both countries are invaded by water hyacinth; parrot's feather [*Myriophyllum aquaticum* (Vell.) Verdc.; Haloragaceae]; water lettuce (*Pistia stratiotes* L.; Araceae); salvinia (*Salvinia molesta* D.S. Mitch; Salvinaceae); giant sensitive plant; *Canna* spp.; and bush morning glory.

Higher areas of elevation in Malawi means that this landlocked country is prone to invasion by a suite of species that are unlikely to become invasive in Zambia. However, there are a number of extremely problematic species shared by both countries, especially those affecting water bodies. All of these invasions are being facilitated by climate change; increased land degradation, especially deforestation; and the building of water impoundments which, among others, alter flooding regimes.

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Introduction

The main aim of this Field Guide is to enable people to identify some of the alien plant species that are invasive, potentially invasive, or naturalized in Malawi and/or Zambia (see Figures 1 and 2), and to enable them to learn more about the impacts of these species, often inferred from studies done elsewhere, even on other continents, and about possible options for managing and controlling such plants.

The status of introduced plant species profiled in this Guide was determined through roadside surveys, and through a review of the existing literature, both published and unpublished. Covering only 114 species, this is by no means a comprehensive guide. Indeed, it is probably a very conservative selection, considering that many localities could not be surveyed, and given too that some species, even in surveyed areas, may have been overlooked. Other species may have escaped attention simply because they are not recorded in the literature as being naturalized or invasive in these two countries.

Grasses, for example, which can be very difficult to identify during roadside surveys, were not assessed, with few exceptions. Many *Eucalyptus* (Myrtaceae) and *Pinus* (Pinaceae) species have been introduced into Malawi and Zambia, and cultivated, in some cases becoming naturalized or even locally abundant, but these too can be hard to identify, and as such were not assessed at the level of individual species other than *Pinus patula*, and some *Eucalyptus* species in Nyika National Park. Many other species of vines for example, especially those in the genus *Ipomoea* (Convolvulaceae), are difficult to identify when not in flower. Some species are obscure and difficult to spot, while others are hard to tell apart from native plant species of similar appearance. Herbs are notoriously difficult to identify during roadside surveys and may have been missed, especially when not in flower. So, where a plant species is not recorded as being present in a particular area, this does not necessarily mean that the species does not occur there, only that it was just not seen there during our surveys. As such, it is important to recognise, based on the potential shortcomings highlighted above, that this Guide only provides a baseline for others to contribute and build upon.

In addition, this Guide includes only species deemed to be having a negative impact, or as having the potential to impact negatively, on biodiversity or rangeland production (including through toxicity to livestock), even though many of the species may also have impacts on crop production and on other productive sectors. In other words, introduced plant species that, in our view, impact only on crop production are not included. This is not because such plants are considered to be less important, only that we have chosen to focus on species that are contributing, or which may contribute, to biodiversity loss and reduced pasture/livestock production in Malawi and Zambia, now and in the future. Of interest, most of the species included in this Field Guide were intentionally introduced.

In our view, all the species profiled in this Guide are either naturalized already, or invasive, in Malawi and/or Zambia, or else have the potential to become invasive in the region in the future based on our own personal assessments, that of other researchers or information contained in peer-reviewed

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publications. While it is obvious that some species, including giant sensitive plant (*Mimosa pigra* L.; Fabaceae), mesquite [*Prosopis juliflora* (Sw.) DC.; Fabaceae], lantana (*Lantana camara* L.; Verbenaceae) and water hyacinth [*Pontederia crassipes* Mart.; Pontederiaceae] are invasive, we cannot be entirely certain that other species we have "labelled" as potentially invasive or naturalized, will necessarily become problematic.

The decision to include such species is based on observations in the field and on the ecology and the biology of species and/or of closely related congeners which, elsewhere in the world, are known to have become problematic, threatening biodiversity and livelihoods. So, while some of the listed species may never become problematic, it is better to be 'safe than sorry', and so avoid growing or disseminating exotic plant species that could damage our environment and/or economy in the future. This is what is known as the Precautionary Principle which states that "Lack of scientific certainty about the environmental, social and economic risk posed by a potentially invasive alien species or by a potential pathway should not be used as a reason for not taking preventative action against the introduction of potentially invasive alien species. Likewise, lack of certainty about the long-term implication of an invasion should not be used as a reason for postponing eradication, containment or control measures." As the sayings go, 'a stitch in time saves nine', and 'forewarned is fore-armed'.

This Guide is sub-divided into eight major sections: Aquatics; Climbers (including vines and creepers); Grasses; Ferns; Herbs (including spreading or flat-growing plants); Shrubs; Succulents; and Trees. Some species may be regarded as both shrubs and small trees, or as both small and large trees, or as both shrubs and climbers, but have been included in only one of the sections or categories in order to avoid duplication. For example, all succulent herbs and shrubs have been grouped under Succulents. The species appear in alphabetical order within each section, based on their scientific and not common names.

The text gives the scientific name for each species, along with its English common name, or names, and the local or vernacular names that are most frequently used in Malawi and Zambia. While it has not been possible to get vernacular names for most of the species, especially for those that occur in Zambia, we hope to be able to rectify this in subsequent editions. There is a brief description of each species, complete with line drawings and colour photographs, as well as information on its origin, the reasons for its introduction, the habitats it invades, and its impacts.

The information on impacts has been obtained from multiple sources, often from studies undertaken outside of Malawi and Zambia. This can be instructive in that impacts, for most invasive species, tend to be generic, i.e. similar, irrespective of where a particular invasive species is adventive, but we acknowledge that in some cases impacts may be different; future studies will have to determine that. In most cases, the impacts of introduced plant species within Malawi and Zambia are not well documented in the literature because of a lack of research capacity and resources. It is hoped that the case studies cited in this Guide will lead to a more thorough assessment of impacts within the region in the future.

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The distribution maps presented in this Guide are based on roadside surveys, including surveys of towns, villages and gardens in Malawi and Zambia, although surveys in the latter were rather limited. In some locations such as hotel and lodge gardens, and some small villages, surveys were undertaken on foot. Additional records were obtained from a few published and unpublished sources, covering both countries.

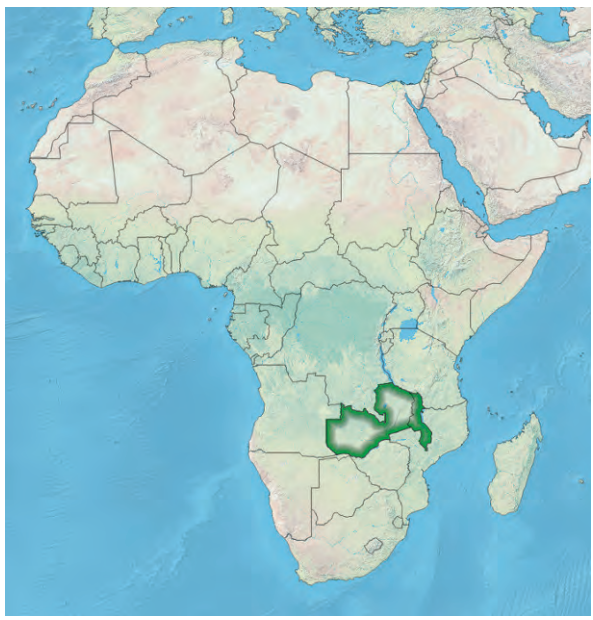


Figure 1. Map showing the location of Malawi and Zambia within Africa



Figure 2. Detailed map of Malawi and Zambia

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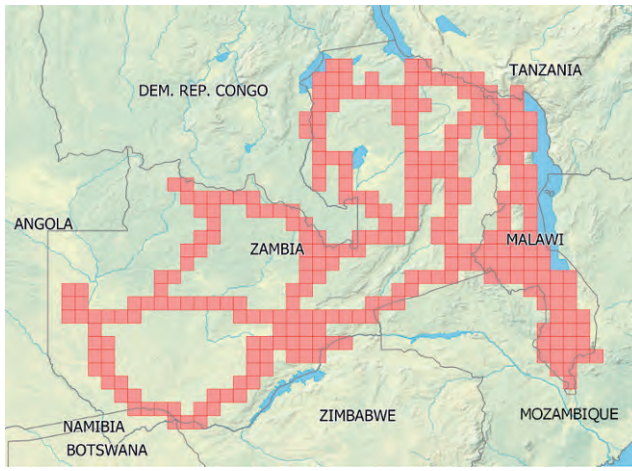


Figure 3. Map showing (in 1/3-degree squares) the areas surveyed in Malawi and Zambia

Surveyed areas (see Figure 3) and the distribution of naturalized and invasive species are represented by 1/3-degree grid squares (~ 37 x 37 km). In the species distribution maps grey grid squares represent the areas that were surveyed, but these are by no means to be taken as an indication that the whole grid was surveyed in any particular case, only that a given species was found to be present somewhere within that grid square. Orange grid squares represent areas where a plant species was found to be present and/or naturalized, and red grid squares represent areas where a species was considered to be invasive. Additional information on the distribution of some of the species in Malawi and Zambia have been included in the narrative.

Alien species were recorded as naturalized if they reproduced consistently, and had established self-sustaining populations that had not yet spread widely or formed dense localized stands, whereas species were recorded as invasive if they had produced large numbers of reproductive offspring that had spread over substantial distances or formed dense stands at a local level. In other words, any species found to be widespread and abundant, or even localized but abundant, was recorded as being invasive. However, it should be noted that we were quite liberal in our assessments, in the sense that we were more likely to allocate the status of invasive to a species that other assessors may only have deemed to be naturalized. That said we are of the opinion that our assessments are largely correct, but we would encourage additional studies to confirm some of our findings. We also assume that all the invasive species present in Malawi and Zambia have been recorded, although some naturalized and (as of now) range-limited species may have been missed. The information on best management practices and on herbicide applications has been adapted mainly from sources in Australia and South Africa.

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What is an alien plant?

- An alien plant is an exotic, non-native, non-indigenous or foreign plant species that has been introduced by people, either intentionally or unintentionally, outside of its natural range and outside of its natural dispersal potential. Plants that have been introduced into an area without the help of people from an area in which they are already exotic are also regarded as alien. In other words, a species which does not belong to the native flora is alien. This includes most of our crops (wheat, maize, rice, potatoes, etc.), ornamental plants and agroforestry species.

What is an invasive alien plant?

- An invasive alien plant is a species of plant that is both alien, as described above, and destructive to the environment in which it grows. As such, invasive plants can have negative impacts on biodiversity and/or livelihoods. It should be noted that most alien species are useful and do not become invasive. In the context of this Guide, destructive alien species that were found to be widespread and abundant, or even localized but nevertheless abundant, were recorded as being invasive within a particular locality. The same criteria were used in recording the status of native species that we consider to be invasive.

What is a naturalized plant?

- In the context of this Guide, a naturalized plant is an alien plant that has established self-perpetuating populations without any human assistance, but which is not yet considered to be invasive, in terms of being either widespread and/or abundant or destructive in the areas where it is found. Most plants that are considered to be naturalized go on to become invasive, but in many cases they do not. The same applies to those exotic species profiled in this Guide that are not naturalized or invasive at present, but which have all of the characteristics or attributes of invasive species; some of these species may never become problematic, but we need to be conscious of their presence in the region and monitor their popuations.

What is a casual alien?

- The term is not used in this Guide but is used elsewhere, and as such it is important for readers to understand what it means. According to Richardson *et al.* (2000), casual aliens are those alien species that may flourish and even reproduce occasionally, but which do not form self-replacing populations, and which rely on repeated introductions for their persistence.

What is a weed?

- A weed is a plant that is out of place and which has not been sown intentionally, or it is a plant growing where it is not wanted. A weed has a negative impact on crop or pasture production, on human or animal health, or on other aspects of economic activity and development, and may be either native or introduced. Yet, while some native weeds may be problematic, in crop production systems for example, those very same

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species, often referred to as pioneers, may also play an important role in plant successions, say, in degraded forests. Pioneers, because they do not persist, allow natural succession to take place, unlike invasive alien species (IAS), which do persist and which inhibit or prevent natural succession processes. The definition of a weed is therefore context-dependent, but in the final analysis, while all invasive alien plant species are weeds, not all weeds are invasive alien plants, because many of them are native to the countries or regions where they occur.

Attributes that enable alien plants to become invasive:

- have no natural enemies in areas into which they have been introduced. In other words, there are no diseases or herbivores which have the ability to attack them, and so reduce their growth rate, reproductive capacity and competitive ability;
- are adaptable in that they are capable of growing in a wide range of habitats and soil types and under various climatic conditions;
- are often plants that have the ability to spread vegetatively (through cladodes, tubers, bulbs, etc.) as well as by seed;
- may be plants that are popular as ornamentals or which are used in agro-forestry, as these plants are more likely to be moved around and are grown in large numbers, contributing to increased propagule pressure;
- are often hardy, having the ability to withstand adverse growing conditions;
- have the ability to grow rapidly and to regenerate quickly after being damaged;
- establish easily, often in nutrient-poor or water-limited environments;
- can make very efficient use of limited resources such as water, nutrients and light;
- mature very rapidly and so produce seeds early, often in large quantities;
- possess efficient and effective modes of dispersal;
- do not require specialized pollinators, having flowers that are easily pollinated by any number of different insects, birds and other organisms; and
- have seeds that can remain dormant for long periods, allowing the plants to persist during periods which are not suitable for active growth.

Invasive alien plants may:

- interfere with crop and pasture production and native plants through competition for available light, water and nutrients;
- physically interfere with the growth of a crop or native plant species;
- displace crops, pasture and native plant species through the production of toxins that inhibit the growth of other plants (allelopathy);
- permanently alter natural ecosystems and the services and benefits they provide in nature and to people;
- impact on soil nutrient cycling (e.g. nitrogen-fixing plants);

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- contaminate harvested crops with their seeds or by tainting (e.g. the seeds of some weeds are toxic, and may result in poisoning if consumed);
- act as secondary hosts for crop pests (i.e. harbour insects, pests or diseases which attack crops);
- provide suitable habitats for organisms that may pose a threat to human or animal health (e.g. waterweeds provide ideal habitats for vectors of human and animal diseases);
- increase shading (in the case of invasive shrubs or trees), which can alter soil temperatures, affecting the growth, reproduction and/or survival of organisms residing in the soil;
- have a negative impact on human and animal health (e.g. pollen from invasive plants may contribute to respiratory ailments in people);
- interfere with the harvesting of crops or forage (e.g. thorny or woody weeds can make it difficult to harvest crops);
- lead to the need for additional cleaning and processing (e.g. weeds with burs may lodge in sheep's wool);
- reduce the amount of available pasture (i.e. weeds may displace valuable pasture species or prevent access to valuable forage);
- be poisonous to people, livestock or wildlife;
- cause physical injuries to people, livestock or wildlife (e.g. weeds with spines, such as cactus species, can cause serious injuries);
- reduce the quality of animal products such as meat, milk, fleeces or hides (e.g. consumption of some weeds, such as parthenium, by livestock, may render their milk and meat unpalatable);
- invade water bodies, affecting water quality and quantity (e.g. waterweeds can dramatically increase water loss through evapotranspiration);
- inhibit water transport (e.g. waterweeds can inhibit or prevent the movement of boats);
- inhibit or prevent hydroelectricity generation (e.g. waterweeds may block turbines);
- block water courses, including irrigation canals (e.g. aquatic or semi-aquatic weeds), leading to flooding;
- inhibit the ability of people to catch fish (e.g. waterweeds, such as water hyacinth, which by covering entire water surfaces can make fishing impossible);
- alter river flows and contribute to riverbank erosion (e.g. semi-aquatic weeds, such as giant sensitive plant, which can reduce water flow rates);
- contribute to erosion of sand from beaches (i.e. weeds used to stabilize coastal dunes can alter soil movement dynamics, reducing sand deposition on beaches);
- interfere with the recreational use of certain areas, especially water bodies;
- reduce tourism potential (i.e. unpalatable weeds can reduce the abundance of wildlife);

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- increase the frequency and intensity of fires (e.g. weeds such as chromolaena, which are highly flammable);
- provide cover for dangerous animals and in many instances for poachers as well;
- prevent access to natural resources (i.e. weeds forming dense impenetrable thickets can prevent access to water and grazing);
- encroach on roads, paths and villages;
- contribute to the abandonment of homes and villages (i.e. a reduction in crop yields and pasture production may force people to move elsewhere);
- are drivers of human conflict (i.e. invasive plants, by eroding the natural resource base on which millions of people depend, may spark conflict, especially over access to water and grazing); and
- reduce visibility along transport corridors.

It has been estimated that weeds in general are causing crop-yield losses of about 10% in less developed countries, and of about 25% in least developed countries (Akobundu, 1987). In the USA, weeds are reducing potential crop yields by 12%, which equates to a monetary loss of about US$ 33 billion annually (USBC, 1998). Roughly US$ 27.9 billion of this lost crop-production revenue is attributed to exotic weeds (Pimentel *et al.*, 2001). In parts of the USA where invasions of field bindweed (*Convolvulus arvensis* L; Convolvulaceae) are dense, crop yields have been reduced by as much as 50–60% (Callihan *et al.*, 1990). Annual crops, such as cereals and grain legumes, are especially badly affected by bindweed invasions, and yield reductions of 20–80% have been recorded (Phillips and Timmons, 1954; Black *et al.*, 1994). Bindweed is also a problematic weed in vineyards. In 1998 alone, losses caused by bindweed in the USA were estimated at more than US$ 377 million (Berca, 2004).

In India, weeds are responsible for an estimated 30% loss in potential crop production, and are thought to be depriving the country of yields worth about US$ 90 billion per year (Singh, 1996). In India, yield losses of 86%, 67%, 48%, 27%, 25% and 18% have been recorded in niger seed, greengram, sesamum, soyabean, black gram, pigeon pea and groundnut respectively, as a result of dodder (*Cuscuta campestris* Yunck.; Convolvulaceae) invasions (Mishra *et al.*, 2007). In the lowlands of Ethiopia, *Parthenium hysterophorus* L. (Asteraceae) is considered by the overwhelming majority of farmers to be the most damaging weed in both croplands and grazing areas (Tamado and Millberg, 2000). There, in experimental fields infested with high densities of parthenium, sorghum yields were reduced by 97% (Tamado *et al.*, 2002). Current average annual economic losses to smallholder farmers in Ethiopia, Kenya, Tanzania, and Uganda as a result of parthenium invasions amounted to between US$ 51.4 and 81.9 million per annum (Pratt *et al.*, 2017).

In Uganda, one-third of farmers interviewed reported a 26-50% reduction in crop yields as a result of lantana (*Lantana camara* L.; Verbenaceae) invasions (Shackleton *et al.*, 2017a). *Chromoleana odorata* (L.) R.M. King & H. Rob (Asteraceae) invasions in northern Tanzania reduced crop yields by more than 50% (Shackleton *et al.*, 2017b) while more than 50% of respondents in

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northern Malawi said that *Mimosa diplotricha* Sauvalle (Fabaceae) reduced crop yields (Witt *et al.*, 2020).

Invasive plant species can also have a dramatic impact on livestock production. About 45% of the weeds in US pastures are alien species, which are together responsible for losses in pasture production worth about US$ 1 billion per year (Pimentel *et al.*, 2001). In Australia, invasions of rubbervine (*Cryptostegia grandiflora* Roxb. ex R. Br; Asclepiadaceae) have reduced the carrying capacities of some pastures by 100%. Economic losses incurred by rubbervine invasions, resulting in reduced cattle-carrying capacities and in increased management costs, have been estimated at A$ 18 million annually to the beef industry of north Queensland, Australia, alone (Agriculture and Resource Management, 2001). This weed is now abundant in many countries in southern Africa and Ethiopia and has the potential to spread throughout much of Africa.

In South Africa, invasions of *Chromolaena odorata* have reduced the carrying capacities of pastures from about six hectares per livestock unit (LSU) to more than 15 ha/LSU (Goodall and Morley, 1995). This is supported by studies in Tanzania where the majority of respondents reported significant reductions in livestock carrying capacities as a result of invasions by chromolaena (Shackleton *et al.*, 2017b). A recent study has shown that natural grazing capacity in South Africa, without management of invasive plants, would be reduced by 71% (van Wilgen *et al.*, 2008). In Australia, infestations of thistle [*Cirsium vulgare* (Savi) Ten.; Asteraceae] have caused losses to the wool industry amounting to an estimated US$ 15 million a year (Davidson, 1990). Most pasturelands in India have been invaded to some extent by *Lantana camara* L. (Verbenaceae), resulting in productivity losses worth almost US$ 1 billion per year (Pimentel *et al.*, 2001). In Uganda, respondents reported that lantana displaced valuable forage species, hindered stock movement and poisoned their animals (Shackleton *et al.* 2017a). It is estimated that introduced weeds in crops and pastures in South Africa, the USA, the UK, India and Brazil result in economic losses of almost US$ 95 billion per annum (Pimentel *et al.*, 2001). A recent study on the impacts of IAS in Africa, determined that yield losses, reductions in livestock derived income and IAS management costs, mainly labour costs, amount to an estimated annual cost of US$ 65,58 billion per annum (Eschen *et al.*, 2021).

Invasive plants can also have a dramatic impact on water resources. In South Africa, invasive alien plants have reduced surface water run-off by about 3,300 million m^3, which is about 7% of the national total (Le Maitre *et al.*, 2000). Declines in water run-off in South Africa, attributed to infestations of *Acacia mearnsii* De Wild. (Fabaceae) alone, amount to an estimated 577 million m^3 annually (Versfeld *et al.*, 1998). Introduced pines (*Pinus* spp.) which have escaped from cultivation in South Africa have had a dramatic impact on water resources. On the Drakensberg in Kwazulu-Natal, pine plantations have reduced stream-flows by 82% (Bosch, 1979), while in the Western Cape stream-flows from invaded fynbos water catchments have declined by 55%. In South Africa, stands of the invasive shrub *Prosopis juliflora* (Sw.) DC. (Fabaceae) transpired (lost) more than five times more water (~544 mm y^{-1}) than stands of the native shrub/tree *Vachellia karroo* (Hayne) Banfi & Galasso

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(Fabaceae) (91 mm y^{-1}) (Dzikiti *et al.*, 2017). If the terrestrial invasive plants now present in South Africa were left to expand their distribution and to occupy their full potential ranges, water losses would increase to about 56% of the national total (van Wilgen *et al.*, 2008).

Invasions of water hyacinth (*Pontederia crassipes* Mart.; Pontederiaceae) and of other waterweeds can also dramatically increase water losses, impacting on a host of other sectors. In southern Benin, an invasion of water hyacinth was found to have reduced the annual income of 200,000 people by about US$ 84 million (de Groote *et al.*, 2003). Water hyacinth invasions are costing seven African countries US$ 20–50 million per year in impact and management costs (Joffe and Cooke, 1997).

Invasive plants have negative impacts on human and animal health. For example, famine weed (*Parthenium hysterophorus*) can cause severe allergenic reactions in people who regularly come into contact with the plant (McFadyen, 1995). In Ethiopia, symptoms recorded in people who have come into contact with the weed on a regular basis include general illness, asthma, irritation of skin and pustules on the hands, stretching and cracking of the skin, and stomach pains (Wiesner *et al.*, 2007). Paper mulberry [*Broussonetia papyrifera* (L.) L'Hér. ex Vent.; Moraceae], a tree that is invasive in Ghana, Uganda, Pakistan, Malawi and elsewhere, produces vast quantities of allergenic pollen, which has been shown to exacerbate asthma in sufferers. In Islamabad, Pakistan, paper mulberry sometimes accounts for as much as 75% of the total pollen count, contributing to ill health or even death in the old and infirm. Water hyacinth also provides breeding sites for vectors of human and animal diseases, increasing the incidence of malaria, encephalitis, schistosomiasis, filariasis, river blindness and possibly cholera (Burton, 1960; Gopal and Sharma, 1981; Spira *et al.*, 1981; Visvam *et al.*, 1989).

In Queensland, Australia, pastoral losses resulting from *L. camara* infestations were in 1985 estimated at US$ 7.7 million, inclusive of lost revenues associated with 1,500 animal deaths, and with reduced productivity and lost pasture production, as well as the costs of control (van Oosterhout, 2004). Invasive *Bryophyllum* species, including *B. delagoense* (Eckl. & Zeyh.) Schinz (Crassulaceae), caused 41 recorded poisoning incidents, affecting 379 cattle in Queensland, Australia, between 1960 and 1984 (McKenzie and Dunster, 1986). In 1997, 125 cattle died after eating this species on a travelling stock reserve near Moree in New South Wales, Australia (McKenzie *et al.*, 1987). In the Sudan, the ingestion by livestock of *Calotropis procera* (Aiton) Dryand. (Apocynaceae) is a suspected cause of ill-health and sometimes even death in sheep and goats (Mahmoud *et al.*, 1979). *Cestrum laevigatum* Schltdl. (Solanaceae), invasive in South Africa and elsewhere, is highly toxic and responsible for numerous livestock deaths (Thorburn, 1934).

Biodiversity is also dramatically reduced by the presence of invasive plants. Indeed, many consider invasive alien species to pose the second biggest threat to biodiversity, after direct habitat destruction. In Australia, lantana alone is threatening the survival of 275 native plant species and 24 native animal species (Turner and Downey, 2010). On Ascension Island,

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Nicotiana glauca Graham (Solanaceae) is displacing endemic species such as *Euphorbia origanoides* L. (Euphorbiaceae), a critically endangered species, and *Anogramma ascensionis* (Hook.) Dielsby (Pteridaceae), through dominating sites and altering ecological conditions (Gray *et al.*, 2005). *Passiflora suberosa* L. (Passifloraceae) along with invasive plants of other species, is threatening *Platydesma cornuta* Hillebr. var. *decurrens* B. C. Stone (Rutaceae), a rare shrub that is endemic to Oahu, Hawaii, and of which only about 200 individual plants remain (Richardson, 2007). In Australia, herpetologists looking for reptiles in a habitat invaded by rubber vine (*C. grandiflora*) could find only a single lizard, compared with 131 lizards in nearby native vegetation (Valentine, 2006).

In South Africa, invasions of *Chromolaena odorata* (L.) R.M. King & H. Rob (Asteraceae) are having a negative impact on the breeding biology of the Nile crocodile (Leslie and Spotila, 2001), while in Cameroon chromolaena is displacing native species in the family Zingiberaceae, a major food source for the endangered western lowland gorilla (van der Hoeven and Prins, 2007). In Lochinvar National Park, Zambia, infestations of *Mimosa pigra* L. (Fabaceae) have reduced bird diversity by almost 50% and bird abundance by more than 95% (Shanungu, 2009). In South Africa, *Prosopis* spp. infestations have reduced bird species diversity in some guilds by more than 50% (Dean *et al.*, 2002). In Ethiopia, *P. juliflora* (Sw.) DC (Fabaceae) has reduced understorey basal cover for perennial grasses from 68% to 2% and the number of grass species from seven to two (Kebede and Coppock, 2015). Transformation of this habitat and the reduction in pasture species is threatening the survival of Grévy's zebra (*Equus grevyi* Oustalet; Equidae) in invaded areas (Kebede and Coppock, 2015).

Introduced plants that become invasive, unlike many other, perhaps more familiar invasive species, such as insect crop pests, generally have a cross-cutting impact, affecting multiple sectors, ranging from biodiversity to agriculture and pastoralism, and from water resources to human and animal health. Once an invasive plant has become established, and is widespread and abundant, it is virtually impossible to eradicate, with the result that its impacts on natural or human-made ecosystems will be permanent, unless ameliorated through ongoing, judicious management. This is why invasive alien plants pose such a menacing threat to livelihoods and economic progress, especially in the developing world, where most people are directly dependent on natural resources for their survival. It is therefore critical that we pool our efforts to manage this scourge, at the local, national, regional, and global levels.

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Types of invasive plants

Invasive plants come in various growth forms, shapes and sizes. As mentioned in the Introduction, invasive plants in the context of this Field Guide have been grouped into Grasses, Aquatics, Climbers, Ferns, Herbs, Shrubs, Succulents, and Trees. While many of the invasive plants included in this Guide can be regarded as benign, others, if consumed by wildlife, livestock or people, are extremely toxic. The symbols used in this Guide provide users with a quick reference to the various growth forms – and to toxicity.



Toxic: These plants are poisonous and can have a negative impact on human or animal health and may even result in death, if consumed. Species which are toxic include lantana (*Lantana camara* L.; Verbenaceae) and common thorn apple (*Datura stramonium* L.; Solanaceae), among others.



Grasses: Herbaceous plants with jointed stems, long and narrow leaves growing from the base, with spikes of small wind-pollinated flowers. These include species such as Spanish reed (*Arundo donax* L.) and fountain grass [*Cenchrus setaceus* (Forssk.) Morrone].



Aquatics: Plants capable of growing in aquatic or semi-aquatic environments. These include species such as water hyacinth [*Pontederia crassipes* Mart.; Pontederiaceae] and water lettuce (*Pistia stratiotes* L.; Araceae). Some shrubs or small trees, such as giant sensitive plant (*Mimosa pigra* L.; Fabaceae), may also be regarded as semi-aquatic, although they have been included under the 'Tree' section in this Guide.



Climber/Vine/Creeper: Plants which can grow over and smother other vegetation. These include species such as Madeira vine [*Anredera cordifolia* (Ten.) Steenis; Basellaceae], balloon vine (*Cardiospermum grandiflorum* Sw.; Sapindaceae) and a number of *Ipomoea* species (Convolvulaceae). It should be noted that some large shrubs such as Mauritius thorn [*Caesalpinia decapetala* (Roth) Alston; Fabaceae], and even lantana (*Lantana camara* L.; Verbenaceae) may also be considered to be climbers as they have the ability to grow over other vegetation and 'climb' into trees. However, in this Guide the latter species are included under the 'Shrub' section, with the exception of Mauritius thorn, which is considered to be predominantly a climber.



Ferns: Plants that possess true roots, stems, and complex leaves but that do not have flowers or seeds. Ferns generally reproduce by producing spores. They include species such as sword fern [*Nephrolepis cordifolia* (L.) Presl].



Herbs: Small non-woody plants, usually no more than about 1 m tall, with generally green, soft, often single stems. These include species such as common thorn apple (*Datura stramonium* L.; Solanaceae) and Mexican poppies (*Argemone* spp. L.; Papaveraceae). Species such as *Catharanthus roseus* (L.) Don (Apocynaceae) and *Mirabilis jalapa* L. (Nyctaginaceae) are often considered to be herbs or shrubs, but in this Guide they are included under the 'Shrub' section.

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Spreading or flat-growing herbs or ground covers: Plants with green, soft and horizontal stems that root wherever they come into contact with the ground. Examples include species such as Singapore daisy [*Sphaegneticola trilobata* (L.) Pruski; Asteraceae] and creeping sensitive plant (*Mimosa pudica* L.; Fabaceae). The latter is sometimes also considered to be a small shrub.



Small shrubs: Woody plants that are smaller than large shrubs and trees, as described below. Often multi-stemmed and reaching heights of 1 m or less, these include species such as coffee weed [*Senna obtusifolia* (L.) H.S. Irwin & Barneby; Fabaceae] and ant bush, *Senna occidentalis* (L.) Link (Fabaceae).



Large shrubs: Woody plants that are smaller than trees and often multi-stemmed, reaching heights of 2 m or more, and which can form dense stands. Examples include lantana (*Lantana camara* L.; Verbenaceae), and *Ipomoea carnea* Jacq. (Convolvulaceae). Many of these large shrubs have the ability to climb over or into other vegetation, and so may also be regarded as climbers. However, in this Guide they are included under the 'Shrub' section.



Succulents: Plants with thick, fleshy leaves or stems, used for storing water. Usually found in arid or semi-arid regions, these include species in the genus *Opuntia*. Many of these species, such as sweet prickly pear [*Opuntia ficus-indica* (L.) Mill.; Cactaceae], may also be considered to be shrubs or even small trees. Some succulents, such as *Bryophyllum fedtschenkoi* (Raym.-Hamet & H. Perrier) Lauz.-March, may be considered to be ground-covers, herbs or even small shrubs.



Small trees: Woody plants that are larger than shrubs and which usually have only one erect perennial stem or trunk. Generally reaching heights of a few metres (less tall than 'large trees' as decribed below), these plants have wide crowns and, in many cases, form dense thickets. Examples include leucaena [*Leucaena leucocephala* (Lam.) de Wit; Fabaceae] and *Mimosa pigra* L. (Fabaceae), although some may consider the latter to be a large shrub.



Large trees: Woody plants that are larger than shrubs and which usually have only one erect perennial stem or trunk, supporting a wide crown, but which (unlike small trees) may reach heights of several metres. Examples include black wattle (*Acacia mearnsii* De Wild; Fabaceae) and *Pinus patula* Schiede ex Schltdl. & Cham. (Pinaceae).

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What can we do to manage invasive alien plants?

In order to be effective, all invasive alien plant management strategies need to consider activities related to: (i) prevention; (ii) early detection (surveillance) and rapid response (EDRR); and (iii) control.

Prevention: As most of the invasive plants present in Malawi and Zambia were intentionally introduced, the most effective way to prevent further introductions is to prevent their introduction in the first place. To that end it is important to evaluate the potential of an introduced plant to become invasive prior to introduction. This can largely be determined by undertaking a Risk Assessment (RA) which, amongst other factors, considers the biology of the species, characteristics of the environment to which it is being introduced and if it has been recorded as being invasive elsewhere. Undertaking RA on exotic species which are already present should also be encouraged, so that those plant species which show a high risk of becoming invasive in the future can be eradicated, if possible. It should be noted that climate change, increased disturbance and propagule pressure are all factors that may drive an exotic species, which may appear to be benign now, to become invasive in the future. Prevention is the most cost-effective activity within a holistic invasive species management strategy. As the saying goes 'an ounce of prevention is worth a pound of cure'.

Early detection and rapid response (EDRR): If authorities, competent bodies or even landowners have failed to prevent the introduction of an invasive or potentially invasive species, and it has established in the field, it is critical that it be detected early and eradicated, before it becomes widespread and abundant. To that end it is important that a surveillance strategy be developed and implemented. If an invasive or potentially invasive species is detected, but it is already abundant and widespread, a containment strategy needs to be implemented to prevent its further spread and action taken to mitigate its negative impacts.

Control: If surveillance did not result in the early detection of a potentially problematic plant, and eradication is no longer feasible because it is already widespread and abundant, it is essential to implement a control strategy. A control strategy could include the use of cultural, physical or chemical methods or a combination of some or all of these measures, followed by rehabilitation or restoration. However, before any control is implemented it may be wise to consider these points:

- If possible, undertake a socio-economic survey among communities and/or other target groups to determine the impacts of the invasive plant species on livelihoods or other economic sectors. If there is disagreement among the community as to the costs and benefits of the target species, it is recommended that a cost–benefit analysis (CBA) be undertaken. To acquire sufficient information to undertake a CBA it may be necessary to undertake additional field trials/surveys to support or refute the findings of the socio-economic assessment.
- It is critical that action be taken in order to garner support for control of the target species from government officials and local communities. This

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may take the form of meetings, workshops and/or the development and dissemination of awareness material.

- Inform all stakeholders as to the identity of the target species, its impacts and management options. A lack of support from communities will be a major barrier to the long-term success of any management activities.
- Demarcate and map the area targeted for control and calculate the costs associated with any control activities – these should include the costs of equipment, transport, labour, herbicides, nurseries to grow plants for restoration activities, etc. Note should be taken of the presence of other invasive plants which may invade the area once the target species has been removed. Costs associated with their control also need to be included.
- Develop baseline data on the density, distribution and impacts of the target species in order to measure the efficacy of control operations and benefits to local communities.
- Ensure that you have sufficient resources to undertake initial control, for follow-up activities and if required rehabilitation or restoration.
- If best management practices are not known, or there is resistance from the community to the implementation of particular control activities, it is suggested that demonstration trials or similar be established to reassure communities about the efficacy and safety of selected methodologies.
- The most cost-effective way of managing infestations is to initially contain the current infestation and then initiate control of the less dense or isolated populations first before moving onto the densest stands. In other words management strategies should work from 'outside-in', clearing less dense infestations on the periphery of larger and denser infestations first.
- If clearing invasive plants in mountain catchments or similar, it is recommended that invaded areas in higher-lying areas be cleared first before moving onto lower-lying areas because plant propagules (seeds or vegetative material) are more likely to move 'downhill'. This is especially relevant when controlling invasive plants that have invaded riparian zones because most propagules move downstream along with the water flow.
- Try to remove invasive plants before they flower and produce seeds. This is especially relevant and applicable to new infestations detected during surveillance activities.
- It is not advisable to transport plant parts, especially seeds, rhizomes, tubers, bulbs or other vegetative material (e.g. cactus cladodes) from areas where they have been removed for disposal elsewhere. This will most likely contribute to the further spread of the target species. Ideally, the plants that have been removed should be destroyed and left on site.

Examples of control methods

Invasive plants can be controlled using **physical** (manual or mechanical), **chemical** or **biological** means (see below for more detail). **Cultural** control which is the use of fire, flooding or grazing to reduce the abundance of

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invasive plants can also be used in conjunction with other control methods. Cultural control in crop production systems which can include crop rotation, the use of catch crops, winter ploughing, and irrigation management, can also be helpful in controlling problem plants. Overgrazing often facilitates plant invasions by reducing native plant cover, allowing exotic plants to establish and spread – most invasive species thrive on disturbance. Overgrazing can lead to a reduction in fire frequency and intensity. An absence of fires can facilitate the establishment and proliferation of many invasive plants, especially succulents such as cacti, which are sensitive to fires. Livestock owners should therefore practise rotational grazing and apply the correct stocking rates.

A critical component of invasive species management, which is often not implemented, is that of **rehabilitation or restoration.** Rehabilitation involves activities which convert a cleared piece of land into land suitable for use in terms of habitation or cultivation. The objective of restoration, on the other hand, is to restore land cleared of invasive species to a situation where it matches, as close as possible, the original condition. The latter may involve activities to restore various ecological processes. Cleared areas are very prone to re-invasion, while restored areas are more resistant to invasive plant regeneration and invasion. Restored areas generally also require fewer follow-up activities to remove emerging seedlings and to clear novel plant invaders, and as such can result in significant long-term cost savings.

In areas where degradation is not severe, restoration can be achieved through accelerated natural regeneration (ANR), which relies largely on activities or actions that facilitate natural processes, such as seed germination of native species from the soil seed bank. Factors such as overgrazing and fire, which may harm the regeneration of native plants, can be limited through judicious management. Livestock may be excluded during the regeneration process, while weeding, along with the application of fertilizers and of mulching around regenerating native plants, coupled with direct seeding and steps that will attract seed dispersers, are encouraged (FORRU, 2006).

ANR can be facilitated by enrichment planting or framework forestry. Enrichment planting simply means planting more trees or shrubs of the existing native species, in order to boost their population densities, or else planting trees and shrubs of other native species, in order to enhance overall species richness. Framework forestry involves planting the minimum number of tree species required to reinstate the natural processes of forest regeneration and biodiversity recovery. Framework species include indigenous, non-domesticated forest trees which, on being planted in cleared areas 'rapidly re-establish forest structure and ecological functioning' (Elliott *et al.*, 2003). The principles for grassland or savannah restoration are similar.

The most cost-effective way of controlling invasive plants is by combining two or more of the methods mentioned above – as in, for example, manual control applied in conjunction with chemical and/or biological control. This is commonly known as **integrated pest management (IPM)** and should be implemented whenever possible in order to reduce costs and improve the efficacy of control across a landscape.

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The benefits of weed or invasive alien plant management or control are significant, and are well understood in crop production systems. However, few studies have looked at the costs and benefits of an integrated management strategy across a range of sectors, with the possible exception of biological control, which in almost all cases has shown a positive return on investment. Those few studies that have looked at the benefits of an integrated approach to invasive plant management across a range of sectors, have also found it to be a wise investment:

- Brown and Daigneault (2014) found that an integrated approach to the control of the invasive tree *Spathodea campanulata* Beauv. (Bignoniaceae) in Fiji, derived monetized benefits of US$ 3.7 for each US$ 1 spent even without explicitly considering biodiversity, culture and other non-monetized benefits of control.
- Costs of aquatic weed control in Florida in the late 1960s were estimated to be US$ 6 million annually and benefits were reported as US$ 82 million, with the largest benefits coming from increased land use (due to drainage) and prevented flood damage (Lovell *et al.*, 2006).
- Zavaleta (2000) determined that the annual costs of invasive *Tamarix* species (Tamaricaceae) to the western United States was US$ 280-450 per hectare. Eradicating the invader and restoring native riparian communities throughout its invasive range would cost approximately US$ 7400 per hectare. Full recovery of these costs would occur in 17 years, after which the economic and ecological benefits of restoration would continue to accrue indefinitely.
- An analysis of the costs and benefits of the invasive Australian tree, *Acacia mearnsii*, in South Africa, suggest that a 'do nothing' scenario (with no attempts being made to control the spread of the species beyond the limits of plantations) is not sustainable, as the cost: benefit ratio is around 0.4 (de Wit *et al.*, 2001). The most attractive control option will be a combination of biological control of the whole plant (flowers, seed pods, leaves and stems) and physical clearing, assuming commercial growers can protect plantations at a low cost (cost: benefit ratio of 7.5) (de Wit *et al.*, 2001).
- Based on current values, if the invasive tree *Miconia calvescens* DC. (Melastomataceae) is allowed to expand and reach its full distribution in Hawaii, its impacts on forest ecosystems will amount to US$ 3.08 and US$ 4.6 billion on Oahu and Maui, respectively (Burnett *et al.*, 2007). To retain the current population into perpetuity will cost US$ 10.5 and US$ 73.5 million for Oahu and Maui, respectively. However, if Oahu switches to the optimal policy of population reduction, instead of spending US$ 321,000 per year from today into the future, a present value benefit of US$ 6.5 million can be realized. If Maui switches to an optimal policy of population reduction, a net present value benefit of US$ 34.5 million is possible (Burnett *et al.*, 2007).
- Under a dynamic simulation of an ecological-economic model of alien plant control, in a mountain fynbos ecosystem in South Africa, it was found that the cost of proactive clearing would range from 0.6% to 4.76%

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of the economic value of ecosystem services, but increase the value of these services between 138% and 149%, depending on the assumptions of the model (Higgins *et al.*, 1997).

- De Lange and van Wilgen (2010) estimated the value of ecosystem services in South Africa at ZAR 152 billion (presently, about US$ 19.7 billion) annually of which an estimated ZAR 6.5 billion was lost every year due to invasive alien plants. However, the loss would have been an estimated additional ZAR 41.7 billion had no invasive plant control been carried out. Between 5% and 75% of this protection was due to biological control.

Cultural control

Cultural control of invasive plants can include the use of grazing, flooding, and fire. Grazing can either promote or reduce weed abundance at a particular site. Increased disturbance as a result of the presence of livestock or other grazers can actually facilitate densification and the spread of some invasive plant species. However, if grazing treatments can be combined with other control techniques, such as herbicides or biocontrol, severe infestations can be reduced. Flooding can also be effective in controlling some invasive plant species, but is very difficult to implement in natural environments, and as such rarely used. Fire is more widely used to control unwanted plants in the natural environment and when combined with other control methodologies can be effective.

Fire can be a very cheap and effective way of controlling specific invasive plant species but its efficacy largely depends on the target species, the ecosystem in which it occurs, the intensity of the fire and the amount of times (frequency) it can be applied. For example, fires may actually stimulate seed germination of some plant species and as a result contribute to their densification, while species, which are usually susceptible to fires, may actually benefit from a controlled burn if it is implemented at the wrong time of the year. For susceptible species, the efficacy of a controlled burn can be further enhanced if used in combination with other control techniques, such as herbicides and biocontrol.



Fire: Especially effective for controlling succulents such as species in the Cactaceae and Crassulaceae. Can also be used to reduce the abundance of young seedlings or saplings of other invasive plants and can be used to control invasive grasses. Control efficacy is enhanced if used in combination with herbicides. For example, the significant biomass of clump grasses can be reduced using fire, and herbicide can then be applied to the emerging shoots, reducing the amount of herbicide that would normally have to be used in the absence of fire. However, before using fire it is critical to understand the ecology and phenology of the target species, when it is most susceptible to fire, and if there is sufficient combustible material in the system to carry an "effective" fire. Precautions should also be taken to prevent the fire from spreading to areas outside of the target area.

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Physical control

Manual and mechanical: Manual control involves the direct removal of the above-ground parts of a plant with an axe or a slasher, or the uprooting of plants using a hoe, a garden fork or a spade, or by hand pulling. It may also include ring and strip barking. Mechanical control may involve the use of machinery or equipment (e.g. bulldozers or tractors) and can, among others, involve pushing, stick-raking, blade ploughing and/or chaining of larger plants or medium density infestations. Mechanical control is often used to remove dense stands of woody weeds but can be expensive and may leave soils bare and so susceptible to erosion and re-invasion by invasive plants of the same species or of other species. Soil disturbance associated with manual control may stimulate the germination of weed seeds in the soil seed bank.



1. Uprooting: Physically removing a weed from the ground using tools such as hand-hoes, picks, garden forks, mattocks or even the "tree popper" (www.treepopper.co.za). Suitable for most woody weeds, especially when in the seedling or sapling stage. Not suitable for weeds with deep root systems or which produce suckers. All below-ground plant parts, which can result in the re-establishment of the target species, need to be removed and disposed of in a safe and effective manner.



2. Hand pulling: Similar to uprooting and widely used to remove seedlings and young plants of most invasive plant species; works best when the soil is moist. Take hold of the stem at ground level and pull out vertically. Try to remove plants when they are not fruiting in order to limit the spread of seeds. All below-ground parts of target species, which have rhizomes, tubers or other regenerating vegetative structures, need to be removed and disposed of to prevent their re-establishment.



3. Slashing or felling: A mower, slasher, machete, axe, saw or other tool is used to cut down a plant just above the soil surface. Only suitable for use against weeds that do not coppice or regrow from the rootstock (e.g. *Pinus* species). However, some species, such as *Acacia mearnsii*, will coppice readily from cut stems less than 10 cm in diameter, but larger trees will not do so. Felling can also be used in combination with foliar herbicide application for species that coppice or regrow. For example, large shrubs can be cut down at ground level and herbicide applied to the coppice or regrowth.



4. Ring barking: Removing a 30 cm band or strip around the stem or trunk of a shrub or tree at a height of about 50 cm. It is important to remove all of the bark and cambium. Not suitable for use on multi-stemmed plants, or on plants that coppice or produce root suckers. Hardwood species generally die after ring barking, whereas most softwood species can survive ring barking.



5. Strip barking: Stripping all of the bark from the stem or trunk from about 75 cm to below the soil surface using an axe or similar tool. Only suitable for species with bark that strips easily (e.g. Australian *Acacia* species).

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6. Mechanical control: The use of heavy machinery, such as tractors or bulldozers, in conjunction with ploughs or similar equipment. For example, blade ploughing, grubbing and chaining is utilized in Australia to control invasive *Prosopis* species. Ploughing can also be used to control herbaceous plants, although this is largely limited to crop production systems. Mechanical harvesters can also be used to control waterweeds.

Advantages of manual control

- In most cases, little training or supervision is required.
- Tools are simple, cheap and easily obtainable in all countries – and with hand pulling no tools are required.
- In most cases, little or no harm is caused to the environment – desirable vegetation is not damaged by the hand pulling or uprooting of weeds.
- It can be used in countries where no herbicides are registered for use against a particular weed species.

Disadvantages of manual control

- Procedures are labour intensive, and can be expensive in countries with high labour costs.
- It is physically demanding and slow, and it usually requires repeated follow-up operations.
- Where machinery is used, manual control can be expensive – incurring fuel and maintenance costs.
- Soil disturbance may stimulate seed germination among weeds, and on steep slopes or on riverbanks this may also exacerbate soil erosion.
- In dense infestations, native species are often inadvertently damaged or removed.

Chemical control

Chemical control is the use of herbicides, applied alone or in combination with other methods. A herbicide is a naturally occurring or man-made substance that alters the metabolic processes of a plant, so the plant is either killed or suppressed, or its growth habit altered. Herbicides can be divided into groups according to their modes of action. Non-selective herbicides will affect any plant they come into contact with, whereas selective herbicides can, for example, be used in crop production systems to kill weeds without impacting on the crop itself. However, it is important to recognize that non-selective herbicides can be applied selectively. For example, tree stumps can be treated with little risk to other plants growing nearby. Non-selective herbicides can also be injected into target species without affecting nearby plants.

Contact herbicides affect only the plant tissue they come into contact with, whereas systemic herbicides are translocated or moved throughout the plant from the initial point of application. So, for example, a chemical applied to the stem can be translocated to the roots and leaves, eventually killing the whole plant. Translocated herbicides may move either through the phloem (the living tissue which transports carbohydrates from the leaves or storage organs) or the xylem (non-living tissue that moves water and minerals from the roots to the shoots). Translocated herbicides can be selective or non-selective.

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Pre-emergence herbicides, applied to the soil before weeds emerge, are often used in crop production systems, but are rarely used to control invasive plants in natural environments. Post-emergence herbicides, applied to weeds after they have emerged, are most frequently used to control environmental weeds.

It is important, in many cases, that herbicides are applied together with an adjuvant or adjuvants. Adjuvants are substances added to spray mixtures to enhance the efficacy of herbicide applications or application characteristics. They may include buffers and acidifiers, compatibility agents, de-foaming agents, deposition aids, dyes, stickers and surfactants. In some cases, the addition of an adjuvant is recommended, but in others it is important they are not used. Surfactants are the most important adjuvants because they facilitate the movement of the active ingredient into the plant. They include 'surface-active' chemicals such as penetrators, wetters, stickers and spreaders. These chemicals change the surface tension of the spray droplets, enhancing the spreading of droplets and their adherence to leaf surfaces.

- **Wetters** reduce the surface tension of spray droplets, facilitating their spread over the leaf surface. This also makes it easier for spray droplets to adhere to a waxy or hairy leaf surface. Many of these products are based on soaps or detergents.
- **Stickers** improve the retention of spray droplets on the plant once good wetting and coverage has been achieved.
- **Penetrants**, as the name implies, increase the penetration potential of the applied chemical into the plant.
- **Carriers** are used to dilute or suspend a herbicide formulation during its application – water and diesel are the most commonly used. Diesel can also assist in penetration.
- **Anti-foam agents** prevent the formation of foam in the spray tank, preventing the loss of active ingredients in the foam.
- **Anti-evaporants** are added to slow the evaporation of droplets of volatile herbicides, giving the herbicide more time to penetrate the target plant.
- **Emulsifiers** promote the suspension of one liquid in another, allowing the product to mix with water or oils such as diesel.
- **Solvents** are used in liquid formulations to disperse the active ingredient uniformly in the medium.
- **Stabilizers**, already present in most herbicide formulations, promote and maintain a uniform distribution of active ingredient throughout the spray tank, while prolonging the shelf life of the active ingredient(s). Products are available which can be added to enhance the effect described.
- **Buffers** maintain the desired pH (acid or alkaline) of spray mixtures in the tank.
- **Drift control agents** control the size of spray droplets.
- **Dyes** are substances that stain areas where the herbicide has already been applied in order to show visually which plants have already been sprayed or treated and which have not.

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A herbicide formulation will therefore include:

- the active ingredient(s);
- additives that enhance herbicide effectiveness, stability or ease of application, such as surfactants and adjuvants; and
- other additives such as solvents, carriers or dyes.

Factors that influence the efficacy of herbicides

- Seedlings are very sensitive to foliar applied herbicides – those of the contact type especially. On the other hand, systemic herbicides require both a large leaf area and active plant growth for efficient translocation.
- Stressed plants cannot absorb or translocate a herbicide efficiently.
- Rainfall or irrigation immediately after application can wash a chemical off the plant before it has been absorbed.
- Sometimes, if a mixture of products is used, one of the products may interfere with the action of another, reducing the overall efficacy of the application. Conversely, some chemicals can complement or enhance the efficacy of others.
- Insufficient coverage, resulting from the use of incorrect equipment, may reduce the efficacy of the application.
- Sediments, in the form of fine organic matter or clays in dirty water, may block spray nozzles. Active ingredients may bind with suspended solids and reduce their efficacy.

Advantages of chemical control

- In many cases, there are no other effective options.
- In most cases, chemical control is more cost-effective than other methods, especially manual control.
- Results are quicker than with manual control, especially when compared with ring barking or stripping.
- Use of the correct herbicides, applied according to label recommendations, has little to no negative impacts on the environment.

Disadvantages of chemical control

- The purchase of specialized equipment and the training of applicators are essential, and can add to costs.
- Herbicides can be expensive – incorrect formulations can result in poor control, requiring repeated applications, which can add to costs.
- Target species must be 'healthy', and weather conditions suitable, at the time of a herbicide's application.
- Foliar application can affect non-target species.
- Herbicide misuse may cause environmental damage.
- Manual control of plants may be necessary before herbicide application (e.g. in cut-stump treatments) or in the spraying of re-growing or coppicing plants that were too tall to spray initially.

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1. Foliar applications:

Foliar spraying is the use of a herbicide, diluted with water, sprayed over the foliage (leaves and stems) of seedlings, shrubs, grasses or dense vine infestations to the 'point of runoff' (until every leaf is wet). Some herbicides will require the addition of stickers and wetters in order to improve efficacy. With plants that have been slashed or cut down, the coppice or regrowth should ideally have reached a height of 50–100 cm before spraying, if effective control is to be achieved. This method of control should generally be considered only for large and dense infestations where risks to non-target species are minimal. Efficacy may be influenced by: (i) the available surface area of the leaves; (ii) the position of the leaves; (iii) hair density on the leaves; and (iv) the thickness of the waxy layer on the leaves.

NB: Poor water quality may reduce a plant's herbicide uptake. Soil particles in water may also block spray nozzles. Active ingredients may bind with clay particles in the water, further reducing efficacy. As such, river water should not be used.

Advantages of foliar application

- Easy to apply.
- Large areas can be sprayed in a relatively short period of time.
- Small areas, or even individual plants, can be targeted.
- Ideal for follow-up work to kill seedlings or coppicing plants.
- Herbicides can be applied at lower concentrations than are needed for basal bark or cut-stump treatments.
- Minimal soil disturbance.
- Relatively cheap.
- Not labour intensive.

Disadvantages of foliar application

- Cost of spray equipment.
- Inconsistent or inadequate application rates, influenced by factors such as difficult terrain (steep slopes, rocky outcrops, etc.) and high plant densities, or by laxness on the part of operators.
- A herbicide's efficacy, as determined by its rate of uptake by targeted plants, may be affected by a host of environmental factors, as well as by the condition of the plants. For example, rainfall shortly after application will wash off the herbicide. Uptake will also be reduced in plants that are covered in dust, or which are stressed (through high temperatures, drought, water-logging or leaf damage caused by diseases or by insect attack).
- Can be undertaken only during the growing season of the plants.
- Cannot be applied in windy areas, while the wind is blowing.
- Potential spray drift may result in off-target damage.
- Large quantities of clean water are required at a spray site.

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2. Stem applications:

No pre-treatment of the targeted plant is required. Herbicide is applied directly to the stem of the growing plant.



a. Basal stem application: Usually applied to thin-barked woody weeds, tree saplings, regrowth and multi-stemmed shrubs and trees with basal diameters of no more than 20 cm. The entire circumference of the trunk or stem from ground level to a height of 30–100 cm is sprayed or painted. To help bark penetration, an oil-soluble herbicide is mixed in diesel/kerosene/mineral turpentine/penetrating oil/mineral oil or in other formulated oil blends. The full circumference of every stem or trunk rising from the ground needs to be saturated with the herbicide solution. Trees with old or rough bark may require increased coverage. Application may be made at any time. Bark should not be cut or removed before a basal stem application. Herbicide uptake will be reduced in plants with trunks that have been scorched by previous fires.



b. Total frill: Using a hand-axe, a panga or machete, make horizontal cuts into the sapwood tissue of the stems or trunks of trees, vines or woody weeds, and then insert herbicide into the cuts. Cuts are made at waist height around the circumference of the trunk. While still in the cut, the axe or tomahawk is leaned out to make a downward angled pocket, to which 1–4 mL of herbicide solution is IMMEDIATELY applied (within 15 seconds of making the cut), using a syringe or hand-held sprayer. A partial frill requires a few large cuts on all sides of the tree (5–10 cm apart), while a total frill requires a complete ring of level downward slanting cuts near the base of the stem. DO NOT ringbark the tree, as this will decrease herbicide uptake into the plant.



c. Stem injection: Also called drill-and-frill. Using a battery-powered drill or similar tool, make holes (at a 45° downward angle) in the stems or trunks of trees, cacti, vines or woody weeds, and IMMEDIATELY (within 15 seconds of drilling the hole) apply herbicide in the drill hole, using a squeeze bottle or plastic syringe. This technique targets the sapwood (cambium growth) layer just under the bark, which will transport the chemical throughout the plant. Do not drill too deeply or you will get into the heartwood, which will not take up the herbicide. Drill four holes for smaller plants, and a maximum of 12 holes for large plants. Stem injection relies on the active uptake and growth of the plant to move the chemical through its tissues, so plants that are already stressed may not be killed.

Similar to this is the **tree spearing** method whereby a specifically designed tree spear is thrust into the base of the tree at an angle of 30–40° from vertical. A herbicide solution is applied IMMEDIATELY to the holes/cuts, which are spaced approximately 5 cm apart.

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Advantages of stem applications

- Most procedures are simple and require little preparation or training.
- The ability to kill large standing trees in locations where felling might damage native vegetation.
- Minimal disturbance is caused to surrounding vegetation, and no soil disturbance.
- It is less labour intensive than felling trees (using cut-stump applications).
- It is target specific, with little or no potential for herbicide drift (hence minimal non-target impacts).
- It is ideal for controlling weeds that can be difficult to kill using other methods.
- Can be applied at any time of the year.

Disadvantages of stem applications

- The need for some training, in the case of certain procedures.
- Diesel, used as a carrier, can be expensive, and is usually more toxic to people than the herbicide itself.
- Dense infestations may require large quantities of diesel, which may contaminate the soil and/or water.
- Large standing trees that have been treated, and which are dying, may fall suddenly or drop branches, and as such may be dangerous.
- The woody biomass within large trees cannot be utilized to offset control costs.
- Frill and stem injection techniques can be slow.

3. Stump applications:

These include procedures that involve cutting down a plant at the base of the stem, and then immediately applying herbicide to the stump.



a. Cut stump: Sometimes also referred to as “cut and spray” or “lopping/pruning”. Sever the plant completely at its base (no higher than 15 cm above the ground), preferably horizontally using a chainsaw, brush-cutter, machete or even secateurs or pruning loppers (tool selection will depend on ease of cut, as determined by the thickness of the stem/trunk), and IMMEDIATELY apply herbicide (with a paint brush, a squeeze bottle, a sponge-tipped bottle or a spray bottle). Application delays of more than 15 seconds for water-based herbicides and 1 minute for diesel-soluble herbicides, from cutting to chemical application, will give poor results. For trees with trunks of large circumference, the herbicide solution should be applied only around the edges of the stump, targeting only the cambium layer. Apply to the point of wetting, but not to the point of runoff. Treatments can be applied at any time of the year.

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b. Total stump: Sever the plant completely at its base (no higher than 15 cm above the ground) using a chainsaw, axe, brush-cutter or machete. Once cut, the herbicide solution can be sprayed or painted onto the exposed cut surface and to the sides of the stump down to the root collar area, using a knapsack sprayer, a paint brush, a drench gun or a hand-held spray bottle. This method is generally used on trees with stems of small circumference. For vines with aerial tubers (e.g. *Anredera cordifolia*), both cut ends have to be treated with herbicide. Hold cut stems in a container of herbicide solution for 15 seconds after cutting, so that maximum translocation will occur.

Advantages of stump applications

- They are target specific, with negligible potential for herbicide drift (hence minimal non-target impacts).
- Tall foliage can be treated.
- They are relatively cost-effective in that only small amounts of herbicide are used.
- One application is usually enough to kill the target plant.
- Can be done in winter – outside of the growing season.
- There is no soil disturbance.

Disadvantages of stump applications

- Cutting down trees or shrubs is labour intensive.
- It can be time-consuming when dealing with large infestations.
- May require some training.
- Felling large trees can damage native vegetation.
- Sudden removal of the canopy can stimulate seed germination among weeds, and expose the soil to erosion.
- Diesel, often used as the carrier, can be expensive, and is more toxic to people than the herbicide itself.
- Some herbicides are long-acting and may be absorbed by non-target plant species growing nearby.



4. Scrape and paint:

Scrape a very thin layer of bark, using a sharp knife, from a 10–30 cm section of stem (taking care not to cut through the vine), and IMMEDIATELY apply the herbicide to the exposed green underlying soft tissue (before the plant can seal). Removing a small portion of the bark will allow the herbicide to penetrate into the plant's sapwood. For large shrubs and vines, several scrapes, placed approximately 7.5 cm apart, may be required.

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Advantages of scape and paint

- It is effective because herbicide is placed directly onto the target plant, with the result that non-target impacts are negligible.
- It is relatively cost-effective in that only small amounts of herbicide are used.
- One application is usually enough to kill the target plant.
- Gradual defoliation of a target plant will allow plants of native species growing nearby to recover over time, while also preventing sudden exposure of the soil to erosion.
- There is no soil disturbance.

Disadvantages of scrape and paint

- It may require some training.
- Large standing trees that have been treated, and which are dying, may fall suddenly or drop branches, and as such may be dangerous. They also pose an increased fire hazard.
- It is labour intensive.

NB: The herbicides and the modes of application recommended for controlling most (for some of the plants we could not find any relevant information pertaining to herbicide use) of the species included in this Field Guide are those that are used in Australia and/or South Africa **(see Appendices C and D)**. The recommended herbicides may not be available or registered for use against the target species in your respective countries. If legislation in your country prohibits the use of these herbicides, or they have not been registered for use against a particular target species, it is illegal to use them, unless temporary authorization for experimental trials has been granted by a competent authority. It should also be noted that the information contained in this book is a guideline only and that all herbicide users read and strictly follow all label instructions when using a particular pesticide. The authors of this Field Guide encourages those that choose to use herbicides to:

- purchase products that are registered and fit for purpose;
- obtain the correct advice from accredited advisers;
- ensure correct handling, transportation and storage of products;
- always use protective gear when applying herbicides;
- always read the product labels and follow all instructions relating to the safe and proper use of the product;
- always use the recommended product mixtures;
- always use the recommended equipment;
- take all necessary precautions to avoid non-target impacts; and
- dispose of all containers in a safe manner ensuring that they will not be used for other purposes subsequent to disposal or have a negative impact on the environment.

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Biological control

The use of host-specific natural enemies (pathogens, mites and insects) to control invasive plants has been practised for many decades by a host of countries, especially the USA, Australia, South Africa, Canada and New Zealand. The main aim of biological control is to:

- suppress plant vigour;
- reduce seed production;
- slow plant growth; and
- reduce the density of the weed infestation.

Biological control agents include: (i) gall-forming insects; (ii) defoliators (e.g. leaf-feeding beetles); (iii) leafminers; (iv) sap-suckers such as insects and mites with piercing and sucking mouthparts; (v) flower-, bud- and seed-feeders; (vi) stem-borers; (vii) crown-feeders; (viii) root-feeders; and (ix) disease-causing microorganisms such as bacteria, viruses, fungi and nematodes. In some cases, only one introduced biocontrol agent has been needed for success in controlling an invasive plant invasion. In most cases, however, effective suppression of a target plant species has been achieved through the release of multiple biocontrol agents, which attack different parts of the plant.

The first official programme to control a weed using biological control agents commenced in 1902 when 23 species of insects were sent from Mexico to Hawaii for the control of *Lantana camara* L. (Verbenaceae). Since then, over 500 biological control agents have been intentionally released against nearly 200 weed species around the world. These so-called 'classical' biocontrol projects have been conducted in a total of 90 countries (Winston *et al.*, 2014). In Africa, not including South Africa, 19 weed species have been targeted for biological control since 1913 (Day *et al.*, 2020). In South Africa, biological control agents have been released against 69 invasive alien plants, and established on 66 of these species (Zachariades, 2018). Based on Hoffmann's (1995) definitions, 15 (22%) of these species are under complete control, 22 (32%) are under substantial control, and 17 (25%) are under negligible control, while the remaining 12 (17%) are either currently under evaluation or have not been evaluated. This represents a success rate of 54%, at the level of the target species. In New Zealand (Fowler, 2000), Mauritius (Fowler *et al.*, 2000), Australia (McFadyen, 2000) and Hawaii (Markin *et al.*, 1992) biocontrol programmes have achieved success rates of 83%, 80%, 51% and 50%, respectively,

The main benefits of biocontrol (Greathead, 1995)

- Agents establish self-perpetuating populations, often throughout the range of a target weed, including areas that are not accessible using chemical or mechanical control methods.
- The control of a target weed is permanent.

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- There are no negative impacts on the environment.
- The cost of biocontrol programmes is low, relative to other approaches, and requires only a one-off investment.
- Benefits can be reaped by many stakeholders, irrespective of their financial status or of whether they contributed to the initial research process.

An analysis of some biocontrol research programmes in South Africa found that benefit:cost ratios ranged from 34:1 for *Lantana camara* to 4,331:1 for golden wattle, *Acacia pycnantha* Benth. (Fabaceae) (van Wilgen *et al.*, 2004). It is also estimated that biocontrol agents present in South Africa have reduced the financial costs of mechanical and chemical control by more than 19.8%, or ZAR 1.38 billion (Versfeld *et al.*, 1998). It is further estimated that biocontrol programmes, if fully implemented in the future, may reduce control costs by an additional 41.4%, or ZAR 2.89 billion (Versfeld *et al.*, 1998). In fact, the benefit:cost ratios for biological control of invasive Australian trees, invasive succulents, and subtropical shrubs in South Africa were estimated to be 3,726:1, 2,731:1 and 50:1, respectively (De Lange and Van Wilgen, 2010). These findings are supported by studies in Australia which have found that every dollar invested in the weed biocontrol effort yielded a return of A$ 23.10 (Page and Lacey, 2006). There, the benefit:cost ratio for agriculture alone (in terms of both cost savings on control and increased production) was 17.4. If current annual expenditures on biocontrol research continue into the future, it is expected that weed biocontrol projects in Australia may provide, on average, an annual net benefit of A$ 95.3 million, of which A$ 71.8 million is expected to flow into the agriculture sector (Page and Lacey, 2006).

In southern Benin, the reduction of water hyacinth as a result of biocontrol has been credited with an increase in income of US$ 30.5 million per year to a community of about 200,000 people (de Groote *et al.*, 2003). If one assumes that the benefits stay constant over the next 20 years, the accumulated present value would be US$ 260 million – a benefit:cost ratio of 124:1 (de Groote *et al.*, 2003).

The invasive plants which have been described in this Guide, and for which biological control agents are available, are listed in **Appendix B**. All of the agents listed have established in the identified countries as indicated, although a number have proved largely ineffective, owing to a range of factors.

Guidelines for managing invasive alien plants

When developing and implementing an invasive alien plant management strategy it is recommended that the following steps be followed:

- Inspect the area/property which has been identified for management;
- Record/map the location of all target species in the designated area, the habitats in which they are growing, and the possible presence of biological control agents;

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- Identify all available control options and determine associated costs and benefits, including those for follow-up operations, being aware of the fact that physical and chemical control operations may have a negative impact on any biological control agents that may be present;
- Ensure that sufficient resources are available to reduce and maintain infestations to levels which have been pre-determined and agreed upon by all stakeholders;
- Undertake Environmental Impact Assessments for management options, if required;
- Design, document and implement the management strategy based on inputs from all interested and affected parties;
- Regularly monitor effectiveness, including costs, of the control strategy;
- Record and share the results of the strategy in order to evaluate success and provide lessons learnt;
- Design, document and implement a long-term programme to prevent re-establishment or re-invasion of the cleared area. Ideally this should also include restoration.

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Acknowledgements

The idea of this Field Guide arose from the realization that one of the biggest impediments to effective invasive plant management in Malawi and Zambia has been the lack of information relating to which species are present, their distribution, their impacts and how best to manage them. Community members, protected area managers and rangers, farmers, researchers and others have at one time or another all expressed the need for a Guide, to help them to identify and to monitor invasive plant species in the field. Based on this need we proposed that it be included as an output of the Global Environment Facility (GEF) supported project entitled, "Enhancing sustainability of Protected Area systems in Malawi, and stabilizing agro-production in adjoining areas through improved IAS management." Much of the data, at least for Zambia, was also collected during a previous GEF project, "Removing barriers to invasive plant management in Africa." Both of these projects were implemented by the United Nations Environment Programme (UNEP). We are grateful for their support, and that of the UNEP Task Manager on both of these projects, Mr Max Zieren.

We would also like to express our gratitude to the projects National Executing Agency, the Environmental Affairs Department (EAD) of Malawi, and especially the support of Ms Mphatso Kalemba, the National Project Coordinator. We also received valuable inputs from the staff of the National Herbarium and Botanic Gardens of Malawi. We also acknowledge the contributions made by others during workshops, meetings and informal discussions.

I am also grateful to my colleague Winnie Nunda, for her assistance with surveys, entering data and the sourcing of information. Thanks also to Morris Akiri, CABI Regional Director, and Dennis Rangi, CABI Director General for International Development, for their support in this initiative. Joe Vitelli from Biosecurity Queensland, Department of Agriculture and Fisheries, Australia, and Debbie Sharpe (Natural Resource Management, Department of Environmental Affairs, South Africa) kindly provided information on herbicide use, while Rachel Winston provided additional information for incorporation in the biological control table. Elijah Ngoroge produced all the line drawings, for which I am extremely grateful, as I am to those who contributed images; many thanks, you are all acknowledged where your images appear.

The following additional sources of information were widely used, so I would like to acknowledge all of them:

- The field guide *Alien Weeds and Invasive Plants* (2001) by Lesley Henderson was used to acquire additional information on the descriptions of some invasive plants;
- The field guide *Invasive Alien Plants in South Africa* (2020) also by Lesley Henderson was a very useful resource;
- The guide, *Problem Plants of South Africa* (2001) by Clive Bromilow, was used largely to glean additional information on herbicide use;
- Another guide, *Naturalised and Invasive Succulents of Southern Africa* by Walters *et al.* (2011) was useful for the descriptions it provides of succulent species;

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- Sheldon Navie and Steve Adkins allowed me to use much of the information contained in the website *Environmental Weeds of Australia* (https://keyserver.lucidcentral.org/weeds/data/media/Html/index.htm#A);
- Information on some agroforestry species, known to be invasive, was obtained from the World Agroforestry Centre website (http://www.agroforestry.org);
- Additional information on invasive plants was sourced from the Global Invasive Species Database (http://www.iucngisd.org/gisd/);
- Information on invasive plant impacts in the Pacific was obtained largely from the Pacific Island Ecosystems at Risk (PIER) website (http://www.hear.org/pier/);
- Comprehensive information on the origin, descriptions and impacts of invasive plants was obtained from CABI's Invasive Species Compendium (https://www.cabidigitallibrary.org/product/qi);
- Other source material is listed in the references.

Last, but definitely not least, I would like to thank Imelda and Rudolf. Both not only assisted with the recording of data during surveys, but also had to endure many holidays monopolized by my constant desire to record the presence of naturalized and invasive plant species. Imelda also kindly sourced many of the references and compiled the reference list.

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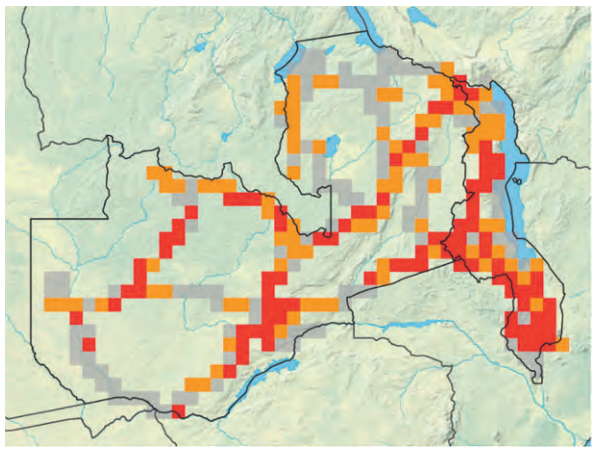
Key to distribution maps

Surveyed areas and the distribution of naturalized and invasive species are represented by 1/3-degree grid squares (~ 37x37 km)

Areas that were surveyed but where no naturalized, invasive, or potentially invasive plant species were seen.

Orange grid squares represent areas where a plant species was found to be present and/or naturalized.

Red grid squares represent areas where a plant species was considered to be invasive.



Sample map

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AQUATICS Page 41

Plants that have adapted to living in aquatic (water) environments, e.g. *Pistia stratiotes* (water lettuce).



CLIMBERS Page 55

Weak-stemmed plants that derive their support from climbing, twining, or creeping along a surface, e.g. *Cardiospermum grandiflorum* (balloon vine).



GRASSES Page 79

Vegetation consisting of typically short plants with long, narrow leaves, growing wild or cultivated on lawns and pasture, and/or as a fodder crop, e.g. *Pennisetum setaceum* (fountain grass).



FERNS Page 85

Flowerless plants which reproduce by spores released from the undersides of the fronds, e.g. *Nephrolepis cordifolia* (sword fern).



HERBS Page 91

Seed-bearing plants which do not have woody stems, e.g. *Acmella radicans* (white-spot flower).



SHRUBS Page 150

Woody plants which are smaller than trees with several main stems arising at or near the ground, e.g. *Ipomoea carnea* (bush morning glory).



SUCCULENTS Page 200

Plants having some parts that are more than normally thickened and fleshy, usually to retain water in arid climates or in dry soil conditions, e.g. *Opuntia stricta* (erect prickly pear).

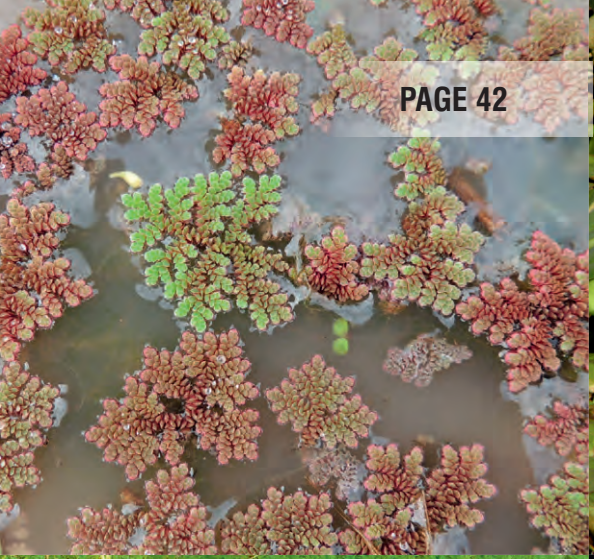


TREES Page 229

Woody plants, typically having a single stem or trunk growing to a considerable height and bearing branches at some distance from the ground, e.g. *Melia azedarach* (syringa).

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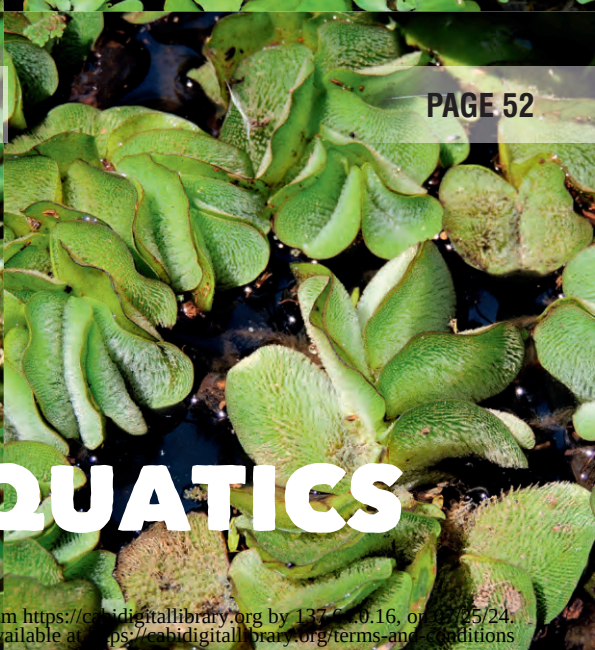
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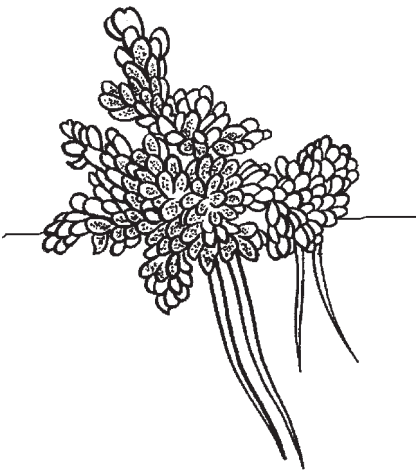


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AQUATICS

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Azolla filiculoides Lam.





WATERMOSS FAMILY
Salviniaceae

COMMON NAMES
English: azolla, large mosquito fern, red azolla, red water fern

DESCRIPTION
Evergreen, free-floating, aquatic fern with horizontal stems (to 25–35 mm long); branching pattern loosely alternate; the roots hang into the water and have fine laterals with 1–3 roots per node.

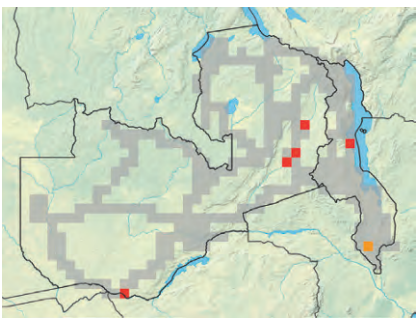
Leaves: Silvery-green turning reddish-brown or purplish in winter, broadly egg-shaped to almost circular (1–1.5 mm long), alternate and overlapping.

Fruiting bodies: Minute, in the axils of the leaves; reproduction also by detached plant fragments.

ORIGIN
Argentina, Brazil, Uruguay and Peru.

REASON FOR INTRODUCTION
Green manure, aquaria and ornament.

INVADES
Ponds, dams, floodplains, swamps, wetlands, lakes and slow-moving rivers.



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IMPACTS

Can grow in water that is low in nitrogen content. Mats, sometimes 30 cm thick, reduce water quality, impoverish biodiversity and increase siltation. Below the mats, which prevent light from penetrating, decaying root and leaf matter creates anaerobic conditions that are detrimental to aquatic organisms. One endangered fish species, the Eastern Cape rocky (*Sandelia bainsii* Castelnau; Anabantidae), is faced with extinction as the result of *A. filiculoides* infestations. Such infestations may also render water unpalatable to people, livestock and wildlife (Hill, 1997). Thick mats, mistaken for solid ground, result in the drowning of animals. Infestations increase water loss through evapotranspiration, while also providing habitats for vectors of disease. Impact costs in South Africa run to an estimated US$ 589 per hectare per year (McConnachie *et al.*, 2003).

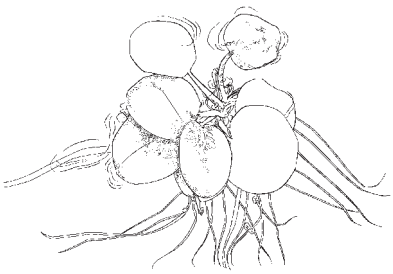
Notes: Not to be confused with two other *Azolla* species present in the region: *A. nilotica* Mett. and *A. pinnata* (R.Br). *A. nilotica* has numerous (5 or more) roots per node with aerial parts that extend upwards from the floating parts; larger than *A. filiculoides*. *A. pinnata* has 2-3 roots per node, but the plant is more pinnate and is never reddish. *A. filiculoides* was recorded as invasive at a few sites in Malawi and Zambia. Present in the northern, eastern and central regions of Zimbabwe (Flora of Zimbabwe, 2020).

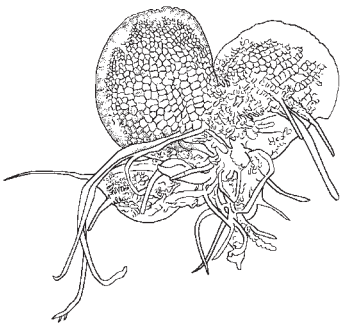






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FAMILY
Hydrocharitaceae

COMMON NAMES
English: Amazon frogbit, smooth frogbit, West Indian spongeplant, South American spongeplant

DESCRIPTION
Floating or emergent aquatic plant, similar to water hyacinth. Young plants grow in rosettes of floating leaves that lie on the water surface; mature plants up to 50 cm tall, with emergent leaves on stalks that are not swollen like in water hyacinth.

Leaves: Green, sub-circular, floating, hairless and glossy above with a thick layer of air-filled spongy tissue below, base rounded.

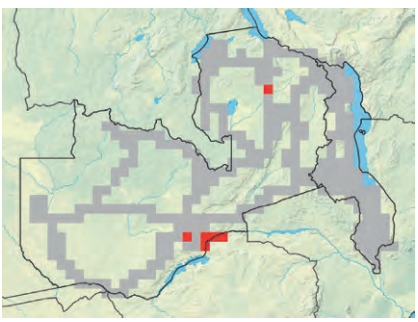
Flowers: White, small.

Fruits: Capsules (dry fruits that open at maturity), (4–13 mm long and 2–5 mm wide), berry-like, fleshy; seeds are oval (1 mm long), hairy.

ORIGIN
Antigua, Argentina, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guyana, Guadeloupe, Guatemala, Guyana, Martinique, Mexico, Montserrat, Nicaragua, Panama, Peru, Puerto Rico, St Lucia, Suriname, Trinidad, Uruguay and Venezuela.

REASON FOR INTRODUCTION
Ornament.

INVADES
Irrigation channels, dams, ponds, floodplains, swamps, wetlands, lakes and slow-flowing rivers.



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IMPACTS

Can spread extremely rapidly through the movement of seeds and stolon fragments in water and wind, but also by birds and boats. Dense mats obstruct waterways (up to 2,500 plants m^2 recorded), which reduces the quality or availability of irrigation water (DiTamaso, 2010). Mats also move with the currents and accumulate on and around infrastructure and as such are likely to impact negatively on the structural integrity of weirs, dam walls, bridges, etc., especially during floods (Akers, 2010). They can also be sucked into water pumps and hydro-electricity turbines causing significant structural damage. Even in its native range in South America it forms dense mats which have been reported to disrupt thousands of kilometres of drainage canals dug for transporting timber (Fernández *et al.*, 1990). Invasions are likely to impact navigation and recreational use of water bodies, and affect biodiversity (Akers, 2010). In California it has escaped cultivation and spread dramatically. There are records of this species in Australia, Indonesia, Japan, Zambia and Zimbabwe. Likely to become as widespread and abundant as water hyacinth.

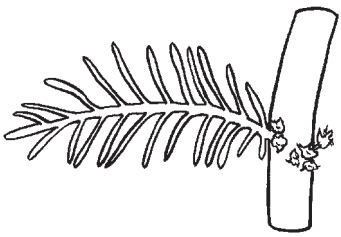
Notes: Not seen in Malawi or Zambia during surveys. However, it is known to be present in dams in and around Harare, Zimbabwe, and on the Zambezi and Kafue Rivers in Zimbabwe and Zambia (Bingham *et al.*, 2016; Howard *et al.*, 2016). Locality data in the distribution map was provided by Phil Weyl (CABI).



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WATERMILFOIL FAMILY
Haloragaceae

COMMON NAMES
English: Brazilian water milfoil, parrot's feather, water feather

DESCRIPTION
Evergreen aquatic plant; rooted, with terminal, leafy shoots rising 20–50 cm above the water surface; stems yellowish-green (2–5 m long and 5 mm thick), with roots forming at the joints.

Leaves: Pale green or bluish-green, feather-like, finely divided, elongated or oval with deeply divided margins (30–45 mm long and 15 mm wide), arranged in groups of 4–6 at the tips of the stems.

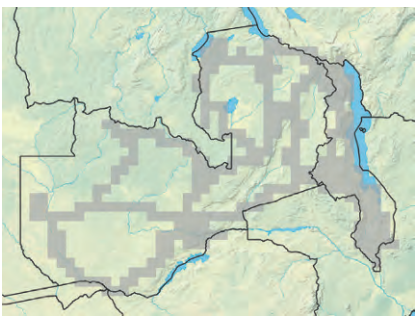
Flowers: Creamy, inconspicuous (1.2 mm long), solitary, in the axis of the leaves.

Fruits: None, spreads vegetatively.

ORIGIN
Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay and Peru.

REASON FOR INTRODUCTION
Ornament.

INVADES
Drainage ditches, irrigation channels, dams, ponds, swamps, wetlands, lakes and slow-moving rivers or streams.



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IMPACTS

Dense infestations exclude native plants and have multiple negative impacts on water transport, fisheries and recreation, while potentially increasing the abundance of mosquitoes. High parrot feather density has been correlated with higher mosquito larval abundance (Orr and Resh, 1992). This aquatic plant rapidly colonizes wetlands and other water bodies, forming dense stands that exclude native water plants (Weber, 2003). In Belgian lakes, native species richness was 57% lower in heavily invaded, compared to uninvaded sites (Stiers *et al.*, 2011). Some rare and vulnerable native plant species were also absent in heavily invaded sites compared to semi-invaded sites. Infestations also shade out algae in the water column that form the basis of the food web, affecting a myriad of organisms (Washington State Department of Ecology, 2011). High tannin content also means that fish do not eat the plant; fish survival is also compromised by a reduction in the oxygen content of the water (Hussner, 2008). Infestations in Germany contributed to a reduction in native macrophyte diversity (Hussner, 2008). In Washington, the Longview Diking District estimates that it spends US$ 50,000 a year on parrot feather control in drainage canals (Washington State Department of Ecology, 2011), while in California, control of this weed over a two-year period cost US$ 215,000 (Anderson, 1993). Also recorded as invasive in South Africa, Zambia, USA, UK, Australia and New Zealand (CABI, 2016).

Notes: Not seen in Malawi or Zambia during surveys although it is known to be present in both countries (CABI, 2020; Flora Zambesiaca). According to Flora Zambesiaca it was already seen in Lake Malawi near Nkhotakota in 1904 and subsequenty in Nkhata Bay, near Mangochi in 1969. Recorded as invasive in all regions of Zimbabwe (Maroyi, 2016).







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Pistia stratiotes L.

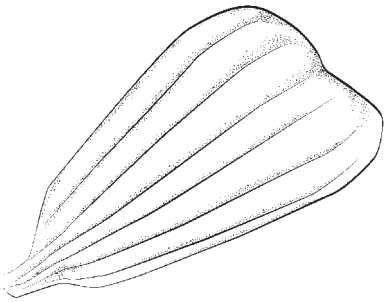


ARUM FAMILY
Araceae

COMMON NAMES
English: Nile cabbage, tropical duckweed, water cabbage, water lettuce
Vernacular: kakombwe, kambumbu, kayandeyande, mphunjira, tenatena

DESCRIPTION
Evergreen aquatic plant forming extensive mats, usually free-floating; consists of a rosette of leaves [15–20 (–30) cm across] with a tuft of long, feathery roots beneath (to 80 cm long); plants develop runners (to 60 cm long); resembles floating lettuce.

Leaves: Pale yellow-green or greyish-green, spongy, narrow at the base and rounded at the tips (2.5–15 cm long and 2–8 cm wide), margins with a series of curved projections, leaves ribbed with 6–15 longitudinal veins radiating from the base; soft, white, velvety hairs on the tops and bottoms of the leaves repel water.



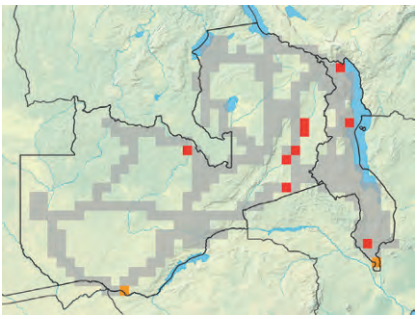
Flowers: Pale green or white, inconspicuous, arising from the leaf forks.

Fruits: Berries (fleshy fruits that do not open at maturity), small, green, egg-shaped or oval (5–10 mm long); containing 4–15 seeds (0.2 cm long and 0.1 cm wide).

ORIGIN
Considered by some to be native to Africa, with a very ancient origin (possibly in the Tethus region), while others maintain that it is native to Brazil.

REASON FOR INTRODUCTION
Ornament.

INVADES
Irrigation channels, dams, ponds, floodplains, swamps, wetlands, lakes and slow-moving rivers.



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IMPACTS

Water lettuce infestations contribute to "increased rates of siltation, the slowing of water flow rates, the degradation of fish nesting sites, increased nutrient loading, thermal stratification, increased alkalinity and mortality among fish and macro-invertebrates" (Dray and Center, 2002). Mats of water lettuce block waterways, making navigation difficult. Dense mats also hamper fishing activities, interfere with hydroelectricity generation and hinder flood-control efforts. They also provide habitats for vectors of disease, and can interfere with rice production (Holm *et al.*, 1977; Waterhouse, 1993). It is considered to be a weed in Africa, Asia, parts of Australia and North America, the Caribbean and the Pacific (Holm *et al.*, 1991).

Notes: Based on our roadside surveys *P. stratiotes* was not as widespread in Malawi and Zambia as expected, despite being present in Malawi for many decades. However, many invasions could have been missed. More than 60 years ago it was recorded as "widespread along the shore of the Lake and mouths of rivers" (Williamson, 1954). The first records in Flora Zambesiaca are from plants collected in Malawi in 1958, at the confluence of the Shire and Ruo Rivers; in the Bua River in 1967; and in the South Rukuru River below Lake Kazuni in 1973. It has also been recorded in Lake Chilwa (Howard-Williams, 1977). In the Shire River it forms "large (6 m diameter) floating mats in bays, lagoons and waterholes" (Blackmore *et al.*, 1988). In Zambia it has been recorded in five provinces (Northern, Eastern, Lusaka, Southern, Western) (Phiri, 2005). It has also been recorded in North (Smith, 1998), and South Luangwa National Parks in Zambia (Astle *et al.*, 1997). Recorded as invasive in the northern, western and southern regions of Zimbabwe (Maroyi, 2012).

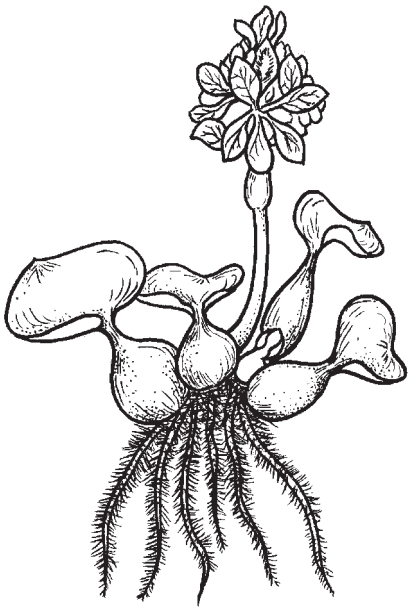


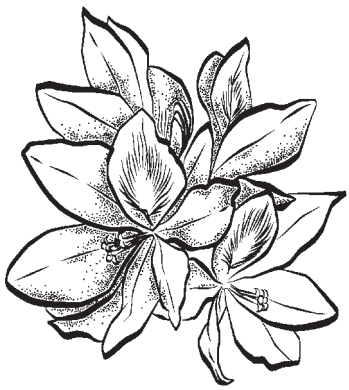




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Pontederia crassipes Mart.





PICKEREL WEED FAMILY
Pontederiaceae

COMMON NAMES
English: lilac devil, Nile lily, pickerelweed, water hyacinth, water orchid
Vernacular: kayandeyande, namasupuni

DESCRIPTION
Evergreen free-floating aquatic plant [usually 10–20 (–100) cm high] that may become anchored in shallow water; roots long and feathery, producing runners (10 cm long) across the water surface that give rise to new plants.

Leaves: Dark green, shiny, hairless, oval to egg-shaped to almost rounded (2–25 cm long and 2–15 cm wide) with swollen bladder-like leaf stalks (30 cm long).

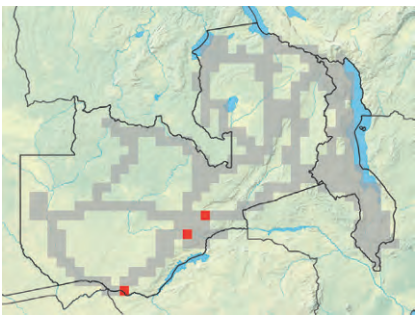
Flowers: Pale violet or blue (4–6 cm long and 3.5–5 cm wide), upper petal of each flower has a prominent yellow-centred patch; flowers in clusters of 8–10.

Fruits: Capsules (dry fruits that open at maturity) (10–15 mm long), containing very fine seeds.

REASON FOR INTRODUCTION
Ornament.

ORIGIN
Brazil, French Guiana, Guyana, Surinam and Venezuela.

INVADES
Irrigation channels, dams, ponds, floodplains, swamps, wetlands, lakes and slow-flowing rivers.



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IMPACTS

This aquatic weed has the ability to form thick mats which hamper water transport; inhibit or even prevent fishing-related activities; block waterways and canals, and hamper hydroelectricity generation, while also providing breeding sites for vectors of human and animal diseases, increasing the incidence of malaria, encephalitis, schistosomiasis, filariasis, river blindness and possibly cholera (Burton, 1960; Gopal and Sharma, 1981; Spira *et al.*, 1981; Viswam *et al.*, 1989). The thick mats reduce light penetration into the water, causing declines in the concentrations of the phytoplankton which support the zooplankton–fish food chain. Extensive mats of water hyacinth increase water loss through evapotranspiration, and impact rice production (Waterhouse, 1993). In southern Benin, an infestation of water hyacinth was found to have reduced the annual income of 200,000 people by about US$ 84 million (de Groote *et al.*, 2003). For men, the lost revenues were mostly fishing-related, while women experienced lost revenues in trade, primarily of food crops and fish.

Notes: Especially abundant on the Shire River in Malawi, but not recorded there during our surveys (limited access), and also locally abundant along parts of the Zambezi and Kafue Rivers in Zambia. Based on anecdotal reports it is also present on some other water bodies, not shown on the distribution map. The first herbarium specimen collected in Malawi was from the Shire River at Liwonde in 1961. According to Flora Zambesiaca the species was also seen in Bangula lagoon, Nsanje District, Malawi, in 1980. Surveys by Blackmore *et al.* (1988) found water hyacinth mats along the Shire River starting four kilometres north of Chiromo in the Namichimba Lagoon to as far as the southern border of Malawi. Along the Shire River it forms “dense mats (up to 300 m in diameter) in lagoons and large bays” (Blackmore *et al.*, 1988). According to Phiri (2005) it is present in Lusaka and Southern Province in Zambia.





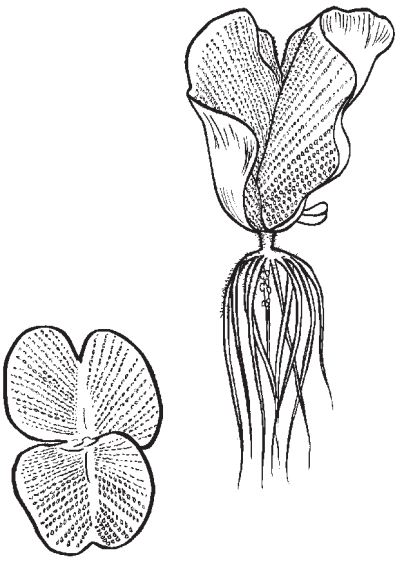




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Salvinia molesta D.S. Mitch





SYNONYM
Salvinia adnata Desv.

WATERMOSS FAMILY
Salviniaceae

COMMON NAMES
English: aquarium water-moss, Australian azolla, butterfly fern, giant salvinia, kariba-weed, salvinia, velvet weed

DESCRIPTION
Evergreen aquatic free-floating fern, forming extensive mats, with branching horizontal stems (6–25 cm long and 1.2 cm thick) and submerged feathery roots.

'Leaves': Green or yellowish-green fronds, in pairs, oval (2–6 cm long and 10–15 mm wide); almost impossible to wet due to a covering of fine egg-beater-shaped hairs (cage-like structures) (1–3 mm long) on upper surface; undersides covered with matted brown hairs.

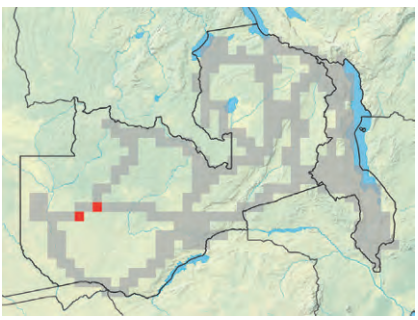
Flowers: None.

Fruits: None, spreads vegetatively from detached fragments.

ORIGIN
Brazil.

REASON FOR INTRODUCTION
Ornament.

INVADES
Drainage ditches, irrigation channels, dams, ponds, swamps, wetlands, lakes and slow-moving rivers.



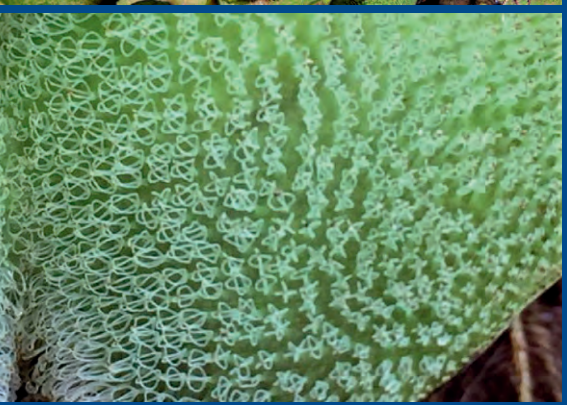
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IMPACTS

Thick mats reduce light penetration into water bodies, impacting negatively on submerged aquatic plants. By out-competing rooted underwater native plants, infestations often reduce plant diversity (Sculthorpe, 1985). The benthic fauna is usually also reduced (Coates, 1982), while fish may be impacted by changes in oxygen concentrations as *S. molesta* plants die and rot within water bodies (Sculthorpe, 1985). It is also a pest of rice paddies in India. Dense mats provide habitats for human disease vectors such as *Mansonia* spp. mosquitoes, which are vectors of West Nile virus, St. Louis encephalitis, Venezuelan equine encephalitis and rural elephantiasis (Pancho and Soerjani, 1978; Chow *et al.*, 1955; Ramachandran, 1960; Lounibos *et al.*, 1990). Mats also harbour snails that transmit schistosomiasis (Holm *et al.*, 1977). Infestations impact negatively on water transport and fishing. Along the Sepik River in Papua New Guinea, infestations of *S. molesta* have led to the abandonment of some entire villages, which had depended on water transport for "access to education, food and healthcare" (Gewertz, 1983).

Notes: Not seen during surveys in Malawi although it has been recorded as present there (CABI, 2020). We are of the opinion that it is more widespread in both countries than indicated, especially in Zambia (Phiri, 2005) where it is known to be invasive in a number of important water bodies such as the Kafue River and Lukanga Swamps. According to Phiri (2005) it is present in four provinces (Copperbelt, Lusaka, Western, Southern) in Zambia and invasive in the northern, western, central, and eastern regions of Zimbabwe (Maroyi, 2012).







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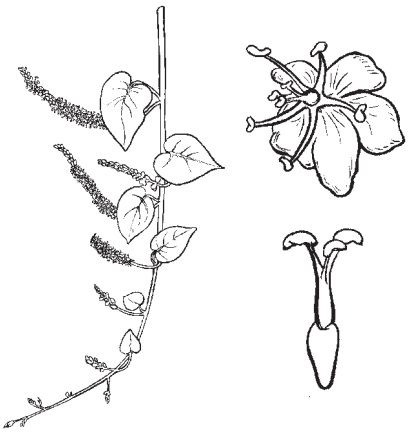
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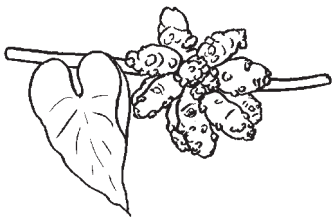
CLIMBERS

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Anredera cordifolia (Ten.) Steenis







MADEIRA-VINE FAMILY
Basellaceae

COMMON NAMES
English: bridal wreath, lamb's tail, Madeira vine, potato vine

DESCRIPTION
Evergreen semi-succulent twining vine or creeper that can grow to over 30 m in height; young stems (to 6 m long) are hairless, green or reddish turning grey-brown and becoming rope-like in appearance.

Leaves: Bright green, glossy and slightly fleshy, heart-shaped (2–15 cm long and 1.5–10 cm wide), held alternately on stems, well-spaced.

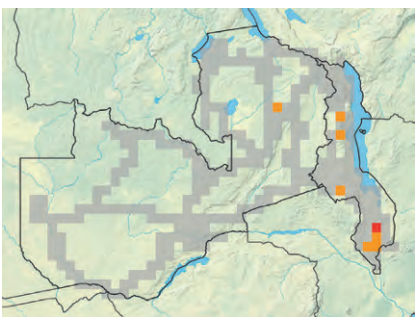
Flowers: White, showy (5 mm across), held in long unbranched inflorescences or spikes (6–30 cm long), short flower stalks (0.5–3.5 mm long), fragrant.

Fruits: Usually not present; reproduces from warty aerial tubers (2–3 cm long) that grow at the junctions of the stems and leaves and which drop to the ground.

ORIGIN
Argentina, Bolivia, Brazil, Columbia, Ecuador, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION
Edible roots, barrier/hedge and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, gardens, plantations, forests, forest edge/gaps, woodlands, woodland edge/gaps and riparian vegetation.



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IMPACTS

It has the ability to cover the ground and to smother native vegetation, including trees, causing canopy collapse. Such is the weight of this creeper, it is capable of breaking off tree branches, "potentially causing collapse of the rainforest canopy" (LCC, 2001). Growth rates of stems in suitable climates can exceed one metre per week and up to six metres in a growing season (Neal, 1965). The aerial tubers through which it reproduces can, after dropping to the ground, remain viable for up to two years, making this an exceptionally difficult plant to manage. As many as 1,500 tubers per m^2 have been reported from under dense infestations (LCC, 2001). It is considered to be one of the worst weeds in Australia and New Zealand. In Queensland and New South Wales, Australia, it is regarded as the most serious threat to rainforest and coastal remnants (LCC, 2001). Invasions threaten the endangered Illawarra socketwood (*Daphnandra* sp. C Illawarra; Monimiaceae) and the endangered Coxen's fig-parrot [*Cyclopsitta diophthalma coxeni* (Hombron and Jacquinot); Psittaculidae] by degrading the latter species' feeding and nesting habitat. It is toxic to pigs, sheep and possibly cattle and goats as well. Poisoning of stock is thought to occur via drinking water, causing diarrhoea and convulsions (Simmonds, 2008).

Notes: Naturalized at some sites, especially in Malawi, where it was also recorded as invasive at one locality. It has the potential to become a serious weed in both countries, especially Malawi. There is an herbarium specimen which was collected at Nthalire in Chitipa District, Malawi, with additional records for Zambia (Flora of Zambia, 2020). "Sometimes escaping" in disturbed forest in Zimbabwe (Flora of Zimbabwe, 2020).







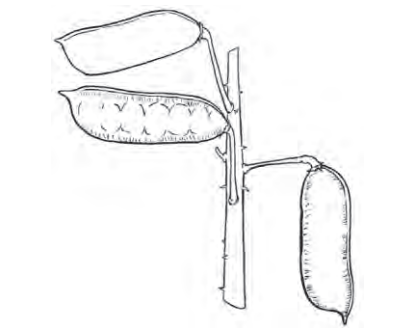


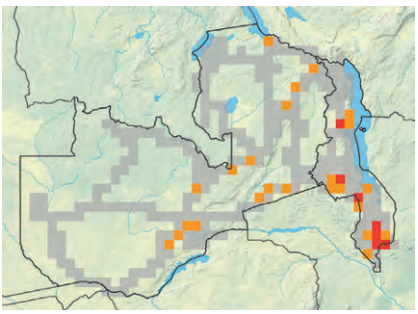
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Caesalpinia decapetala (Roth) Alston









SYNONYMS
Biancaea scandens Tod.; *Caesalpinia sepiaria* Roxb.

PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: cat's claw, Mauritius thorn, mysore thorn, shoofly, wait-a-while
Vernacular: mlunguzi, lunguzi, kapitagwilere

DESCRIPTION
Robust, thorny, evergreen shrub or climber [2–4 (–10) m high]; often forms dense thickets; stems have very fine golden hairs and numerous straight to hooked thorns, not in regular rows or confined to nodes.

Leaves: Dark green above, paler below, twice-divided (to 30 cm long); 4–10 pairs of leaflet branchlets, each branchlet with 8–12 pairs of leaflets which are egg-shaped or somewhat elongated with almost parallel sides (7–20 mm long and 2–8 mm wide), rounded at the ends.

Flowers: Pale yellow (25–30 mm wide), in elongated, erect clusters or spikes (10–40 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature (6–10 cm long and 25 mm wide), flattened, unsegmented and smooth with a sharp beak at the distal end; held stiffly erect on woody stalks; flattened black seeds (8–12 mm long and 6–8 mm wide).

ORIGIN
Bhutan, China, India, Indonesia, Japan, Korea, Laos, Malaysia, Myanmar, Philippines, Sri Lanka, Thailand and Vietnam.

REASON FOR INTRODUCTION
Bee forage, hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, wasteland, gardens, plantations, drainage ditches, forest, forest edges/gaps, woodlands, woodland edges/gaps, savannah, riparian vegetation, lowlands and gullies.

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IMPACTS

Climbs over vegetation, forming tangled, impenetrable thickets, detrimental to fauna and to other flora. Has the ability to grow into forest and woodland canopies, causing canopy collapse. Also grows on to man-made structures, causing infrastructural damage. Mauritius thorn impedes operations in managed forestry plantations and is a fire hazard (Geldenhuys *et al.*, 1986). In Hawaii, *C. decapetala* has invaded pastures, reducing their livestock carrying capacities and inhibiting the movement of livestock and people (Starr *et al.*, 2003). The large spines on the stems can cause injuries to wildlife, livestock and people. In Arusha National Park, Tanzania, Mauritius thorn has reduced native plant diversity (Kisingo *et al.*, 2009).

Notes: In our surveys it was found to be naturalized at a few sites in Malawi and Zambia, but only invasive in Malawi, especially in urban open spaces, riparian zones, and along woodland edges/gaps. It has previously been recorded in the Kota Kota and Lilongwe Districts of Malawi (Williamson, 1954). Often planted around rural homesteads forming an "impenetrable barrier" where it "flourishes to such an extent in the rich soil" that it tends to rapidly occupy the whole area (Williamson, 1954). Bunderson *et al.* (2002) found that it "needs careful management to keep it from overgrowing and becoming a weed, but this is difficult as it is so thorny." Herbarium records from Malawi show the first specimen was collected in 1963 in the Zomba Botanic Gardens. This was followed by collections in Blantyre District and near Dedza Town, Central Region, Malawi. Also recorded as present in Zambia by Drummond (1975) where it is "frequently planted as a hedge where it forms an unpleasant and impenetrable barrier" (Flora of Zambia, 2020). In Zimbabwe it is naturalized in forests and in riverine vegetation (Flora of Zimbabwe, 2020). This agrees with Maroyi (2012), who recorded it as naturalized in the western, central, eastern and southern regions of Zimbabwe.





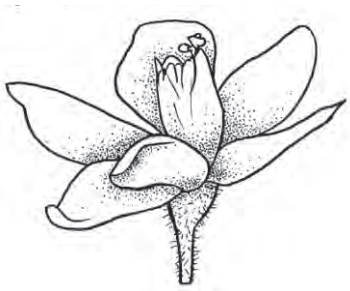


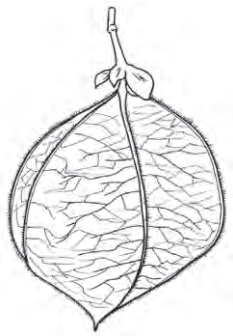


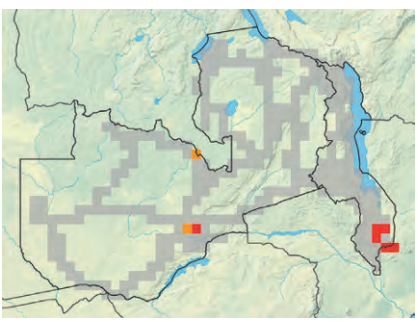
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Cardiospermum grandiflorum Sw.









SYNONYMS
Cardiospermum hirsutum Willd.; *Cardiospermum hispidum* Kunth; *Cardiospermum macrophyllum* Kunth

SOAPBERRY FAMILY
Sapindaceae

COMMON NAMES
English: balloon vine, heart seed vine, large balloon creeper

DESCRIPTION
Evergreen, slightly woody climber [2–5 (–10) m in height] with tendrils (slender, usually twisting structures on the stems or leaves which aid 'climbing'), often smothering trees; stems ribbed and covered with bristly yellowish or reddish hairs especially when young.

Leaves: Bright green, compound (6–16 cm long), leaflets (2–8 cm long and 1–5 cm wide) arranged in three groups of three; margins with forward-pointing sharp projections or teeth and pointed tips.

Flowers: White or yellow, in clusters (about 35 mm long) with two tendrils at the base of each cluster, sweet smelling.

Fruits: Capsules (dry fruits that open at maturity), inflated and balloon-like, green turning brown as they mature, membranous or papery, pointed, much longer than broad (45–65 mm long and 30–45 mm wide), with three compartments; seeds round, black, with an elongated white spot, sides almost parallel.

ORIGIN
Argentina and Brazil.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens, forest edges/gaps and riparian vegetation.

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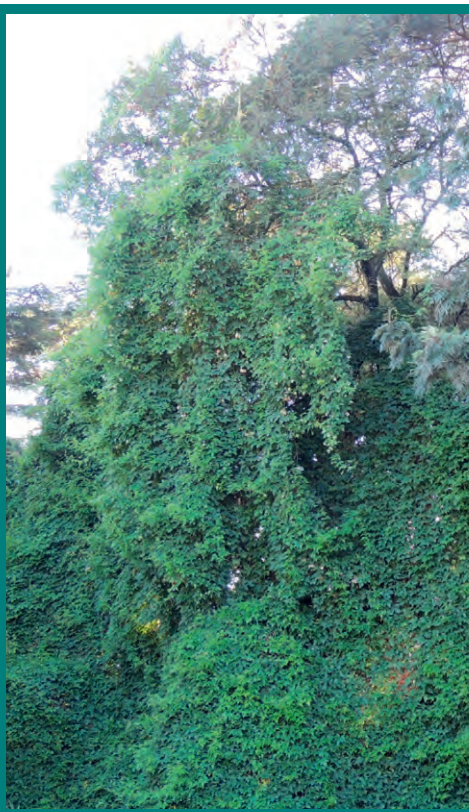
Climbs on to trees and shrubs causing canopy collapse, especially along forest edges and watercourses and in urban open spaces in sub-tropical areas (WESSA, 2006). It forms dense but localized invasions and can grow to enormous lengths, capable of smothering trees up to 10 m tall. Infestations alter light penetration, which suppresses the regeneration of native species. Dense thickets can also restrict the movement of native fauna, preventing access to forage and water sources. *Cardiospermum* spp. invasions have had significant economic impacts on sugarcane and soybean production (Johnston *et al.*, 1979; Jolley *et al.*, 1983; Voll *et al.*, 2004; Subramanyam *et al.*, 2007; Murty and Venkaiah, 2011). For example, in Brazil, *C. halicacabum* has reduced soybean crop yields by up to 26% (Dempsey, 2011; Brighenti *et al.*, 2003). Control of *Cardiospermum* spp. invasions in soybean crops is aggravated by the difficulty of mechanically excluding their seeds, which are similar in size and shape to those of soy (Brighenti *et al.*, 2003).

Notes: Very invasive in some regions in Malawi, where it is smothering vegetation, especially large trees, in and around the towns of Mulanje and Blantyre. The first herbarium specimens were collected in 1965 in Blantyre and Mulanje Districts. Also present in Copperbelt Province, Zambia (Phiri, 2005). It is also widely naturalized in and around Harare, Zimbabwe (Flora of Zambia, 2020), and elsewhere in the central and eastern regions (Maroyi, 2012).









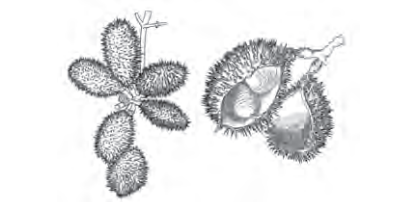
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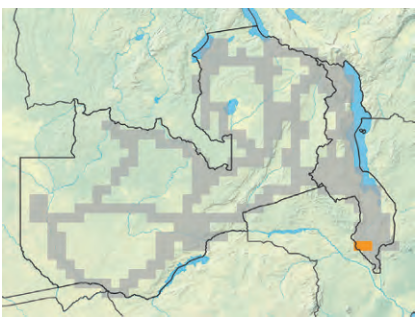
Guilandina bonduc L.











SYNONYMS
Caesalpinia bonduc (L.) Roxb., *Caesalpinia bonducella* (L.) Fleming, *Caesalpinia crista* Thunb.

PEA FAMILY
Fabaceae; sub-family: Caesalpinaceae

COMMON NAMES
English: ash-coloured nut, bonduc nut, Brazilian redwood, fever nut, guilandina seed, nicker-nut caesalpinia, yellow nickers

DESCRIPTION
Long-lived shrub or climber, long stems (to 15 m long), covered in robust straight to hooked prickles or thorns, not in regular rows or confined to nodes; often forms dense thickets.

Leaves: Green, twice-divided (15–80 cm long), (3–) 6–11 pairs of leaflet branchlets, each branchlet with (4–) 6–9 (–12) pairs of egg-shaped or oval to oblong leaflets (2–4 cm long and 1–2 cm wide), base square to slightly rounded, terminal end or apex broadly tapering to rounded, bristle tipped, some hairs on midrib and margins.

Flowers: Pale yellow, flowers held in terminal erect clusters or spikes (30–60 cm long), petals (brightly coloured parts of flower) 6–10 mm long and 2–3 mm wide.

Fruits: Pods (several-seeded dry fruits that split open at maturity), inflated, rectangular (5–8 cm long and 3–4.5 cm wide), green turning brown as they mature, covered with stiff and long hairy prickles (to 9 mm long); seeds pale grey, egg-shaped (1.5–2 cm in diameter), smooth, hard.

ORIGIN
Pantropical including coastal areas in West and East Africa and south along the southern African coastline. Its status in Malawi is uncertain.

REASON FOR INTRODUCTION
Medicine, hedge/barrier, ornament and used as token in board games.

INVADES
Roadsides, disturbed land, urban open space, forest edges/gaps, woodlands, and riparian vegetation.

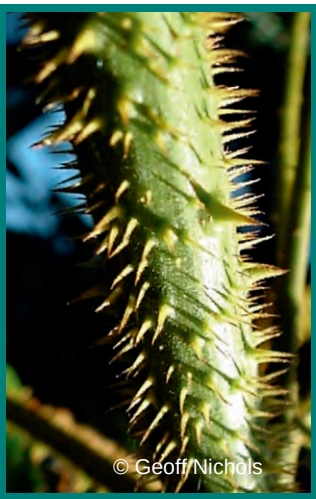
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IMPACTS

Climbs into and over other vegetation, forming dense impenetrable thickets. In tropical Africa it has become naturalized around inland villages probably as a result of seeds being transported for medicinal use and for use in popular board games. Its impacts are unknown but assumed to be similar to those of a closely related species *C. decapetala*.

Notes: It has escaped cultivation in areas surrounding the entrance to Lengwe National Park, Malawi. It was not seen elsewhere in Malawi or Zambia but could have been mistaken for *Caesalpinia decapetala*, so possibly under-reported. Widespread along the Mozambique coast where it is considered to be native (Flora of Mozambique, 2021).





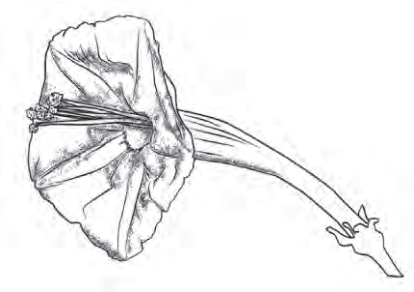






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Ipomoea hederifolia L.





MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: ivy-leaf morning glory, red convolvulus, redstar, scarlet morning glory, star ipomoea, star morning glory
Vernacular: chilalansamba (*Ipomoea* spp.)

DESCRIPTION
Annual twining vine with long stems (3–5 m long) that climb into and over other vegetation, hairless.

Leaves: Green, hairless, variable in shape, roughly triangular and often three-lobed with heart-shaped base and pointed apex; leaf stalk 2–9 (–12) cm long.

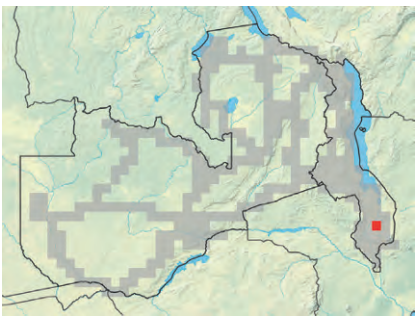
Flowers: Scarlet to red with an orange throat, hairless, trumpet-shaped with tube slightly curved (3–4 cm long), sepals (outer whorl of flower, often green and leaf-like in appearance) 2–3 mm long, with a long awn or horn-like appendage (2–4 mm long); single or in groups.

Fruits: Capsules (dry fruits that open at maturity), usually hairless, round (6–7 mm across), splitting into four valves; seeds (3.5–5 mm long), dark brown or black, hairy.

ORIGIN
Brazil, Bolivia, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Guyana, Haiti, Jamaica, Mexico, Nicaragua, Panama, Peru, Paraguay, and southern USA.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, gardens and forest edges/ gaps.



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IMPACTS

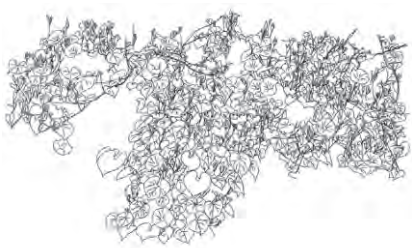
Impacts for most invasive *Ipomoea* species with a climbing habit are similar; they can cause direct population declines in indigenous species by out-competing them for nutrients, water and sunlight in habitats ranging from bushland and riparian woodlands to wetlands and coastal habitats. Several species in the genus are allelopathic, suppressing the growth of other plants (Bah and Pereda-Miranda, 1997). In Australia, *I. hederifolia* has escaped cultivation and is an occasional weed of bushland and riparian areas, as well as sugarcane plantations, roadsides, gardens, disturbed sites and waste areas (Environmental Weeds of Australia, 2016). According to Simpson (2016) it can be invasive in "canefields, cotton crops, and potato fields" and unless treated early, before it reaches the climbing stage on crops, it can be very difficult to control. On some Pacific islands it is a weed in canefields, young plantations, gardens and roadsides (PIER, 2006), being well established in a few lowland areas in New Guinea and common in roadside thickets and waste areas in Tonga (PIER, 2006).

Notes: Grown as an ornamental, it was rarely seen during surveys and was recorded as invasive at only one site in Zomba, Malawi. Probably more widespread than indicated. Herbarium records show that the first specimen was collected in Malawi in 1971, along the shores of Lake Malawi in Chintheche in Nkhata Bay District. According to Flora Zambesiaca it was also collected along the Likhubula River, near Mulanje, in 1980. Also recorded in Copperbelt Province, Zambia (Phiri, 2005) and as a casual alien throughout Zimbabwe (Maroyi, 2012).



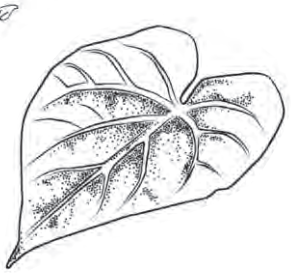
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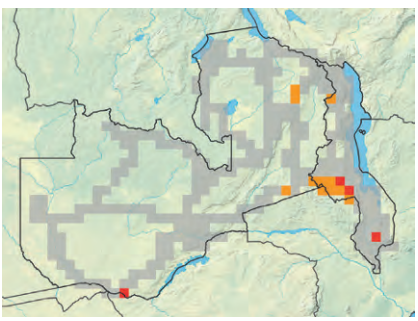
Ipomoea tricolor Cav.











MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: flying saucers, heavenly blue morning glory, Mexican morning glory, morning glory, pearly gates morning glory.
Vernacular: chilalansamba (*Ipomoea* spp.)

DESCRIPTION
Herbaceous short-lived (annual) or evergreen climber with twining stems (to 4 m tall).

Leaves: Green, simple, heart-shaped (3–7 cm long) with smooth margins, narrowly pointed at the terminal end or apex, held alternately on stem; leaf stalks variable in length (1.5–6 cm long).

Flowers: Blue with a white to golden-yellow centre, trumpet shaped (4–9 cm wide).

Fruits: Capsules (dry fruits that open at maturity), rounded.

ORIGIN
Southern Mexico, Guatemala, South America and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, urban open space and riparian zones.



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IMPACTS

I. tricolor has the ability to suppress the growth of other plants (Meira *et al.*, 2012). Impacts are likely to be similar of those recorded for other *Ipomoea* species.

Notes: One of the more commonly grown ornamental *Ipomoea* species in Malawi and Zambia and probably under-recorded during surveys. In the Victoria Falls area it is recorded as an "escaped ornamental, found near habitations" (Pickering and Roe, 2009). According to Flora Zambesiaca it "is not uncommon as an escape in Malawi and neighbouring countries." Herbarium records show the first specimen was collected in Malawi in 1990 in Zomba District. According to the Flora of Zimbabwe (2020) it is "popularly grown as a garden ornamental and occasionally found as a naturalised escape", especially in the western region (Maroyi, 2012).

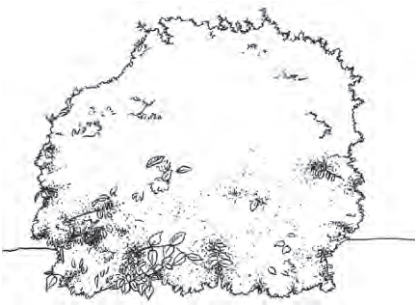


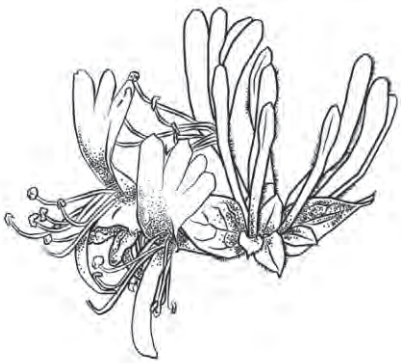


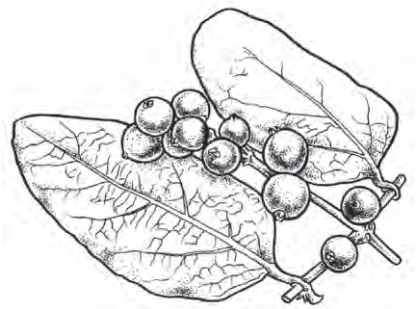


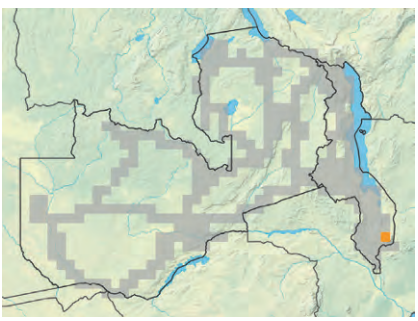
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Lonicera japonica Thunb.









HONEYSUCKLE FAMILY
Caprifoliaceae

COMMON NAMES
English: Chinese honeysuckle, Japanese honeysuckle, woodbine

DESCRIPTION
Semi-evergreen or evergreen climber or scrambling plant (to 9 m high); young stems greenish or reddish and covered with hairs; older stems thick and woody.

Leaves: Dark green and hairless above, pale and slightly downy below, oblong or egg-shaped (2.5–8 cm long and 1–4 cm wide), rounded at the base, tips pointed, margins entire, held opposite each other on stems, on leaf stalks 3–10 mm long.

Flowers: White becoming yellow, sometimes tinged with red (4–5 cm long), held in pairs on stems, fragrant.

Fruits: Berries (fleshy fruits that do not open at maturity), black, egg-shaped to round (5–10 mm long).

ORIGIN
China, Japan and Korea.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Disturbed areas, urban open spaces, woodlands and riparian vegetation.

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IMPACTS

Competing with native plants for light and nutrients, *L. japonica* spreads rapidly, covering and smothering shrubs and small trees (Weber, 2003). Its stems twine around the stems and trunks of native trees and shrubs, cutting water flows and effectively 'strangling' the plants. In North America, it is especially problematic in wetland and riparian margins (Williams and Timmins, 1990, 1998). In forest ecosystems, it prevents the germination and establishment of native plant seedlings resulting in simplified forest structures of "greatly reduced floristic diversity" (ISSG, 2015). It is also a serious weed in Virginia apple orchards, where it inhibits cultivation, dries soil, and provides habitats for mice (King, 1966, in CABI, 2016). In New Zealand, it grows in a wide range of habitats such as roadsides and wastelands, wetland margins, and areas with some woody cover (Williams and Timmins, 1998). In parts of New Zealand, shrublands 4-6 m tall may be completely covered by Japanese honeysuckle (Williams and Timmins, 1998). It is also regarded as invasive in Hawaii (Cronk and Fuller, 1995); the southern parts of Australia where it poses a very serious threat to native vegetation (Carr *et al.*, 1992); southern Chile (Williams and Timmins, 1998), and South Africa (Henderson, 2020). A host of other *Lonicera* species are also known to be invasive outside of Africa, including *L. maackii* (Rupr.) Maxim., *L. morrowii* Gray and *L. tatarica* L. (Weber, 2003).

Notes: Probably significantly more widespread, especially as a garden plant, than indicated. The only naturalized population was found on Mount Mulanje. Herbarium records show the first herbarium specimen was collected in 1970 from the Arboretum at Chongoni Forest Reserve in Dedza District, Malawi. In Zimbabwe it is a "garden plant, occasionally naturalised around Harare" (Flora of Zimbabwe, 2021). Not recorded by Maroyi (2012) as beng naturalized or invasive in Zimbabwe.





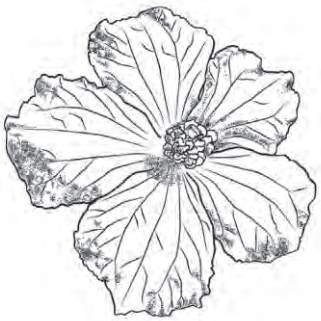




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Luffa cylindrica (L.) N. Roem.







SYNONYM
Luffa aegyptiaca Mill.

GOURD FAMILY
Cucurbitaceae

COMMON NAMES
English: sponge gourd, Egyptian cucumber, Vietnamese luffa, scrubber gourd, smooth loofah, smooth luffa, sponge cucumber, sponge gourd, sponge luffa, towel gourd, vegetable sponge, wild vegetable sponge
Vernacular: buwula, mwepu, siponje

DESCRIPTION
Vigorous-growing vine comprising five angled stems with tendrils on the axils of leaves to facilitate climbing.

Leaves: Dark green with silvery patches on the topside, broadly egg- to kidney-shaped (6–25 long and 8–27 cm wide), 5–7 deep lobes, edges with coarse teeth, rough to the touch, terminal end or apex pointed, base rounded; leaf stalk covered with bristly erect hairs (5–10 cm long).

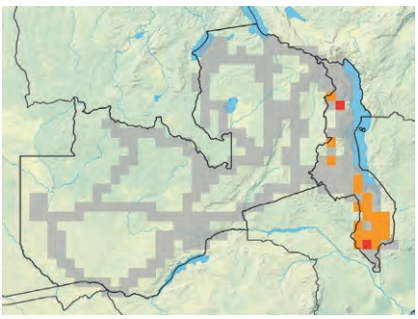
Flowers: Yellow, produced in leaf axils, with five petals (brightly coloured parts of flower) (5–10 cm across), in clusters of 4–20 flowers.

Fruits: Berries (fleshy fruits that do not open at maturity), cucumber-like, green turning yellow as they mature with longitudinal marked lines (61 cm long and 7.6 cm wide).

ORIGIN
Tropical Asia.

REASON FOR INTRODUCTION
Bath sponge, food, medicine, and ornament.

INVADES
Roadsides, disturbed areas, urban open space, and croplands.



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IMPACTS

Its aggressive nature makes it capable of over-growing and smothering other plant species. When grown near fences, it has taken over hedges creating monospecific stands (CABI, 2017). Seeds are easily dispersed by birds, rodents and humans facilitating invasions over large areas.

Notes: Not actively recorded in Zambia, this species was often found to be naturalized in Malawi and invasive at a few sites, smothering native vegetation. However, no large stands were seen anywhere. According to Flora Zambesiaca it has been present in Malawi for over 100 years having been collected on the roadside between Kondowe to Kasonga in 1896. In Malawi herbarium specimens were collected along the Shire River in Chikwawa District in 1970; Mtagaluka Village in Mangochi District in 1979; in Lunyangwa Forest in Mzimba in 1987; Senga Bay in Salima in 1991; and Lilongwe Nature Sanctuary in Lilongwe District in 1998. Present in Northern, Eastern, Lusaka and Southern Provinces in Zambia (Phiri, 2005). Cultivated and escaping cultivation in Zimbabwe (Flora of Zimbabwe, 2020).





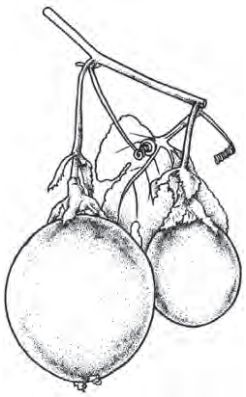


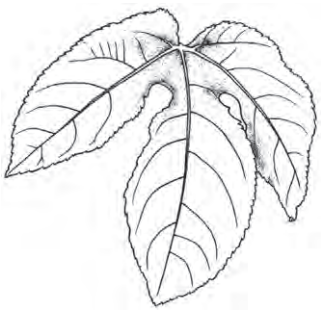


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Passiflora edulis Sims







PASSION FRUIT FAMILY
Passifloraceae

COMMON NAMES
English: granadilla, black passion fruit, common passion fruit, purple passion fruit
Vernacular: galagadeya, magalengendele

DESCRIPTION
Evergreen climber with tendrils (slender, usually twisting, structures on the stems or leaves that aid in 'climbing'), (to 10 cm long); stems sometimes angular (to 15 m high).

Leaves: Glossy dark green or yellow-green above, paler and duller green below, slightly leathery (5–25 cm long and 15 cm wide), deeply three-lobed, lobes oval, elongated, apex pointed, margins finely toothed, on leaf stalks (1.5–5 cm long).

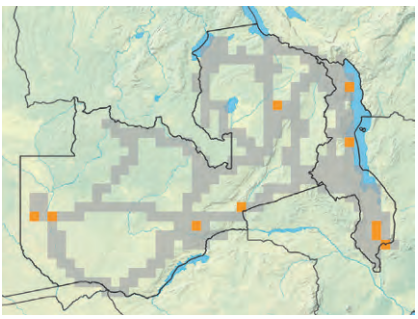
Flowers: Petals white, except for base of corona (middle of flower) which is purple (50–75 mm across).

Fruits: Berries (fleshy fruits that do not open at maturity), greenish-yellow turning deep purple as they mature, round, hairless (5–6 cm long and 4–5 cm wide); pulp is sweet and edible.

ORIGIN
Argentina, Brazil and Paraguay.

REASON FOR INTRODUCTION
Edible fruits and ornament.

INVADES
Disturbed areas, urban open spaces, gardens, forest edges/gaps and riparian vegetation.





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IMPACTS

Climbs into and over trees and shrubs, smothering them, to the possible detriment of biodiversity. According to Weber (2003) invaded forests are species poor. Large trees are killed by the heavy weight of the vines and dense infestations prevent seedling establishment and as a result forest regeneration. *P. edulis* is invasive in the Galápagos, Hawaii, Raoul and other tropical oceanic islands. In Zimbabwe it is a "naturalized, often somewhat invasive weed along the margins of forest and scrub, often in wet or high-rainfall areas" (Flora of Zimbabwe, 2016). It naturalizes and spreads in most areas where it has been introduced.

Notes: Grown as an agricultural crop and occasionally escaping cultivation, smothering other vegetation. Probably significantly more widespread than indicated. Commonly planted in many parts of Malawi, it was already naturalized on Zomba Mountain more than 60 years ago (Williamson, 1954). Also recorded as present in Malawi by Drummond (1975). According to Flora Zambesiaca it was recorded in Malawi at Mzimba in 1968 and on Mount Mulanje in 1970. An herbarium specimen was also collected in 1965 at Shire Highlands Hotel in Limbe, Blantyre District. Present in Copperbelt and Luapula Provinces of Zambia (Phiri, 2005) and recorded as invasive in the central, eastern and southern regions of Zimbabwe (Maroyi, 2012).



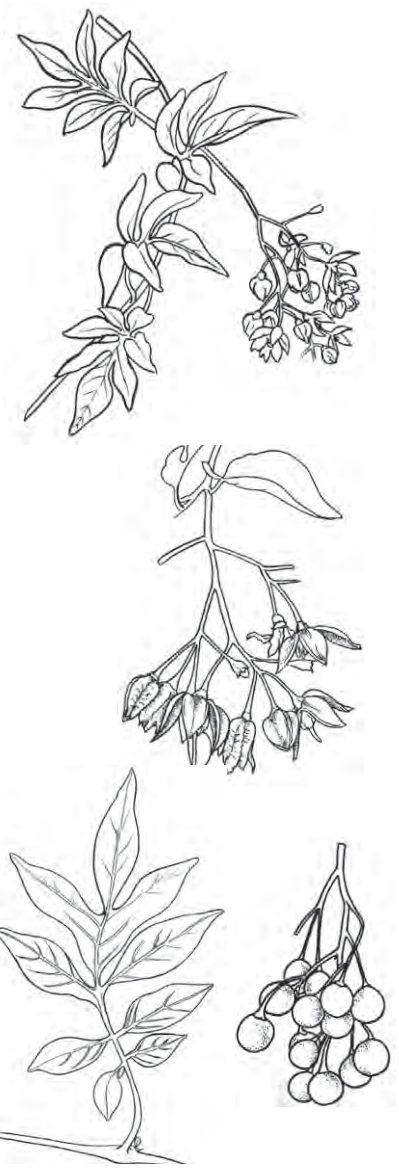


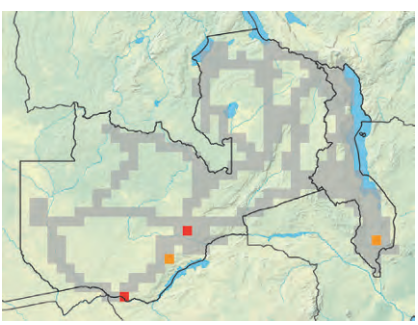




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Solanum seaforthianum Andrews





TOMATO FAMILY
Solanaceae

COMMON NAMES
English: Brazilian nightshade, climbing nightshade, potato creeper, vining solanum

DESCRIPTION
Slender herbaceous or softly woody climber or scrambling vine [2–3 (–5) m high]; stems green, hairless but with a few sticky hairs on the flowering branches.

Leaves: Bright green, hairless, simple (4–13 cm long and 3–11 cm wide) with 3–9 deep lobes (3.5–4.5 cm long and 1–2 cm wide), margins entire, often undulate, with rounded or pointed tips; held alternately on the stems; leaf stalks are variable in length (0.5–6 cm long).

Flowers: Blue to purple, star-shaped (2–3 cm across), in drooping clusters of 10–50 flowers.

Fruits: Berries (fleshy fruits that do not open at maturity), shiny green turning red as they mature, round, small (8–12 mm across), in pendulous or hanging bunches; seeds are brown to black (2–3 mm long).

ORIGIN
Belize, Colombia, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Trinidad and Tobago, USA and Venezuela.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, urban open space, gardens, woodlands, forest gaps/edges and riparian vegetation.

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IMPACTS

Has the ability to form dense stands which may out-compete native species by crowding or by shading them out (ISSG, 2015; Environmental Weeds of Australia, 2016; PIER, 2016). In forest understoreys, a predominance of *S. seaforthianum* can prevent the germination and establishment of native plant species, reducing biodiversity and simplifying forest structure. The species is also toxic, and consumption of the fruits has resulted in cases of poisoning among chickens, as well as in children. Cattle, pigs and sheep have also been poisoned after consuming this plant in mixed fodder (Queensland Department of Primary Industries and Fisheries, 2011).

Notes: Difficult to identify during roadside surveys so probably more widespread than indicated. According to Flora Zambesiaca it was first seen in Malawi in Mchinji District in 1970, and subsequently in Zomba District in 1979. A herbarium specimen was collected in 1967 in Mulanje District. Common in woodlands, climbing over shrubs and anthills in the Victoria Falls area and "may be invasive" (Pickering and Roe, 2009), which can be confirmed by our observations, with significant invasions in the rainforest adjacent to the Falls. According to the Flora of Zimbabwe (2020) it is "widely naturalised and found climbing amongst shrubs and trees in woodland, often on anthills." Maroyi (2012) reported this climber to be invasive in all regions of Zimbabwe.



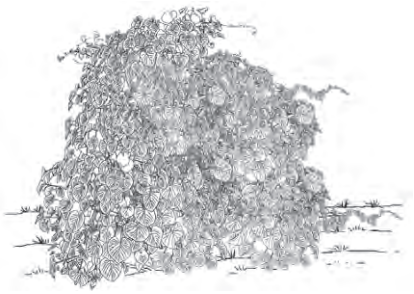


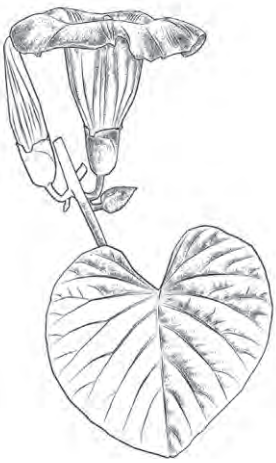


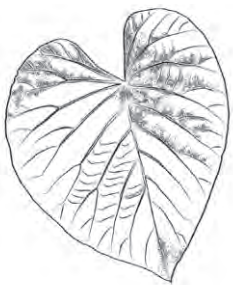


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Stictocardia beraviensis (Vatke) Hallier f.







MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: Hawaiian bell, Hawaiian sunset vine, braveheart vine

DESCRIPTION
A woody climber with finely hairy stems, growing up to 14 m long.

Leaves: Green, heart- to egg-shaped [16 (–23) cm long and 15 (–20.5) cm wide], hairless or with a very few slightly stiffened distinct hairs above, finely hairy or velvety below to hairless below, thin and soft, ending in a distinct point, sometimes blunt; leaf stalk long (17 cm).

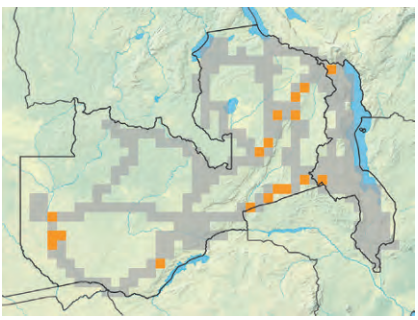
Flowers: Crimson or red-purple with base of tube orange-yellow (3.5 to 5 cm long), funnel-shaped.

Fruit: Capsule (dry fruits that open at maturity), round (1.4 cm long and 1.3 cm wide); seeds black (6 mm long and 4 mm wide).

ORIGIN
Botswana, Burundi, Cameroon, Central African Republic, Chad, Congo, Democratic Republic of Congo, Ethiopia, Ghana, Guinea, Guinea-Bissau, Kenya, Liberia, Madagascar, Mali, Nigeria, Senegal, Sierra Leone, Sudan, Tanzania, Uganda, and Zambia, although other sources state tropical Africa, which would exclude countries such as Botswana, Mali, Sudan, and Zambia. Here we assume that it is introduced to Malawi.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Gardens and urban open space.



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IMPACTS

Competes with other native plants for space and water. It is a fast growing climber, with the ability to cover a fence, trellis, or arbor within a few weeks to a couple of months (TopTropicals, 2019). According to some respondents on Dave's Garden (2020) it is a very aggressive vine. It has been recorded as introduced and with evidence of negative impacts in Botswana (GBIF Secretariat, 2017).

Notes: Probably more widespread than indicated. Grown as an ornamental, or as a hedge, in Malawi and Zambia where it has occasionally naturalized. Recorded as present in North-western and Copperbelt Provinces in Zambia (Phiri, 2005). Considered to be introduced to Zimbabwe but not known to ever become naturalized (Flora of Zimbabwe, 2020).







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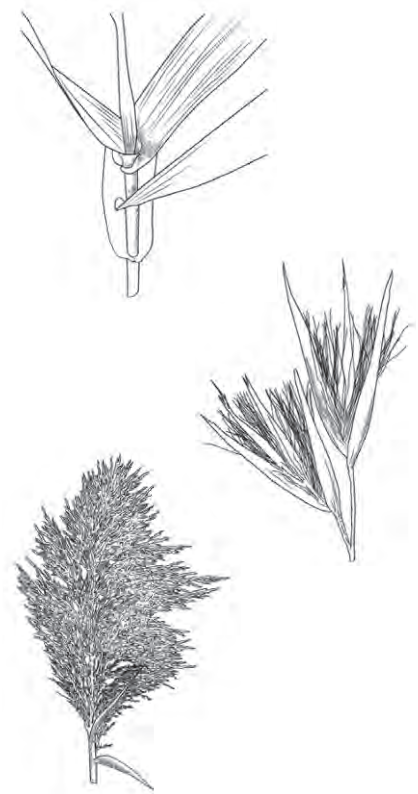
GRASSES

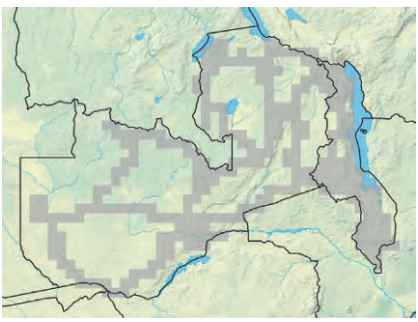
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Arundo donax L.







GRASS FAMILY
Poaceae

COMMON NAMES
English: bamboo reed, giant cane, giant reed, Spanish reed, wild cane

DESCRIPTION
Evergreen, tall, erect reed-like grass [2–6 (–10) m tall] with fleshy, almost bulbous, creeping horizontal rootstocks (rhizome or underground stem) from which grow many fibrous roots; horizonal rootstocks give rise to erect and hollow culms or stems which are divided by partitions (12–30 cm long and 1–4 cm wide) similar to bamboo.

Leaves: Pale green to bluish-green (30–70 cm long and 2–8 cm wide), tapering to a fine tip which is soft or firm, clasping the stem broadly with a heart-shaped, hairy-tufted base (2–6 cm wide); alternately arranged or held on stem; *Phragmites australis* (Cav.) Steud is similar but has narrower leaves (10–35 mm) with rigid and penetrating leaf tips.

Flowers: Cream to brown, held in large plume-like or spear-shaped clusters (30–65 cm long); similar to *P. australis* which has darker seed heads.

Fruits: None seen.

ORIGIN
Afghanistan, Bahrain, Bhutan, Cambodia, China, India, Iran, Iraq, Japan, Kazakhstan, Laos, Lebanon, Malaysia, Myanmar, Nepal, North Korea, Oman, Pakistan, Saudi Arabia, South Korea, Syria, Taiwan, Tajikistan, Thailand, Turkey, Turkmenistan, Uzbekistan, Vietnam and Yemen.

REASON FOR INTRODUCTION
Erosion control, ornament, and screening.

INVADES
Disturbed areas, roadsides, culverts, riparian and other low-lying areas.

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IMPACTS

A very aggressive species with a rapid growth rate, it has the ability to out-compete native species, especially in riparian zones, forming large and dense monospecific stands up to 8 m tall (CABI, 2020). Invasions contribute to increased water temperatures, reduced oxygen levels, and diminished habitat quality for aquatic wildlife (Hoshovsky, 1987; Team Arundo del Norte, 2002, in CABI, 2020). It is estimated that 68% of the riparian vegetation along the Santa Ana River of southern California is occupied by *A. donax* (Dudley, 2000). In some areas, invasions have displaced vegetation utilized by native bird species such as the Least Bell's Vireo (*Vireo belli* Audubon; Vireonidae), a federally endangered species, the willow flycatcher (*Empidonax traillii* Audubon; Tyrannidae), a federally threatened species, and the yellow-billed cuckoo (*Coccyzus americanus* L.; Cuculidae (Bell, 1993). Highly flammable, it can also increase the frequency and intensity of fires. Stands also impact on water flows, contributing to increased sedimentation, flooding and associated infrastructural damage. Listed as one of the world's worst invasive species, it also poses a significant threat to underground water tables, especially in arid and semi-arid areas (Iverson, 1994).

Notes: Not reported as present in Malawi or Zambia (ISSG, 2015; ISC, 2020) although there is a record by Sikatala *et al.* (2019) of its presence in riparian zones in Lusaka, Zambia. Because of the similarities between this species and the native *P. australis*, which is widespread in both countries, we cannot confirm its presence or absence at this stage although the variegated ornamental form was occasionally seen in gardens in Malawi but not recorded. In Zimbabwe, it is "sometimes well naturalised in ditches and by rivers" in the northern and central regions (Flora of Zimbabwe, 2020) whereas Maroyi (2012) reported it as being invasive in the southern and central regions of Zimbabwe.



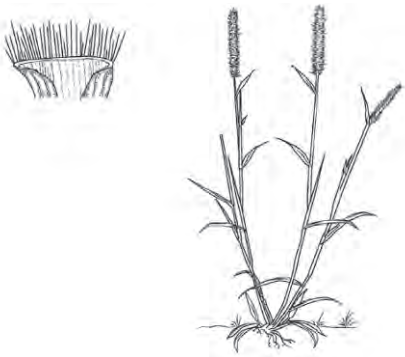




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Pennisetum setaceum (Forssk.) Chiov.







SYNONYM
Cenchrus setaceus (Forssk.) Morrone

GRASS FAMILY
Poaceae

COMMON NAMES
English: African fountain grass, fountain grass, crimson fountain grass, purple fountain grass, tender fountain grass

DESCRIPTION
Evergreen, upright (erect or slightly drooping) tussock-forming grass, unbranched or sparsely branching [20–100 (150) cm high].

Leaves: Green, linear, narrow (15 to 40 cm long and 1–3 mm wide), not rigid or ending in sharp points, slightly rough to the touch, almost hairless but sometimes a few hairs towards the base.

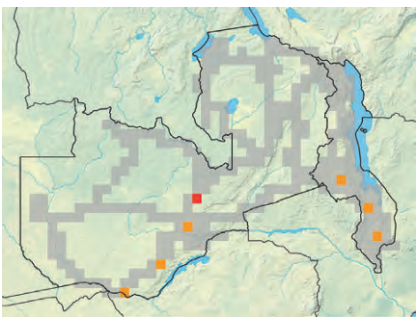
Flowers: Purplish, reddish or pinkish grouped in long and cylindrical spike-like structures with short side-branches [(60–) 100–250 (–300) mm long], feathery, bristles (12–26 mm long) with one significantly larger bristle (16–40 mm long); held on the end of the flowering stems.

Fruits: 'Seeds' (caryopsis or grains) yellow-brown; seed heads turn straw-coloured or whitish when mature.

REASON FOR INTRODUCTION:
Ornament and stabilization of mine dumps.

ORIGIN
North and northeast Africa and southwest Asia.

INVADES
Roadsides, disturbed areas, railway lines, urban open space, mine dumps and associated areas, and rocky outcrops.



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IMPACTS

Forms dense stands displacing native species, reducing livestock carrying capacities and increases the severity of fires. On the Canary Islands, *P. setaceum* initially coexists with native grasses, but eventually displaces *Hyparrhenia hirta* (L.) Stapf., *Cenchrus ciliaris* L., and *Aristida adscensionis* L. (Martin Esquivel *et al.*, 1995). *P. setaceum* is already found in 30% of all protected areas on the Canary Islands (González-Rodríguez *et al.*, 2010). On Hawaii, *P. setaceum* has invaded over 100,000 hectares on the leeward side of the island (Cordell and Sandquist, 2008) increasing fire frequencies and limiting the germination, survival, and growth of native species (Poulin *et al.*, 2007). The high species diversity once common in dry forests in Hawaii are in decline as a result of *P. setaceum* invasions (Cordell and Sandquist, 2007). It is widely distributed in Australia, but most common in coastal areas in south-eastern Queensland, central New South Wales, south-eastern South Australia, and south-western Western Australia where it out-competes and suppresses native vegetation, invades pasture and other habitats, and greatly increases fire risk (Eyre Peninsula Natural Resources Management Board, 2010). Also naturalized in New Zealand, southern USA and on some Pacific islands. Also invasive in South Africa where it invades grassland, savannah, karoo, roadsides, railsides, stony slopes, and drainage lines (Henderson, 2020).

Notes: Grown as an ornamental and used for restoration and the stabilization of mine dumps in the Copperbelt region of Zambia where it is considered to be invasive. According to Phiri (2005) it is also present in Lusaka and Southern Province in Zambia. Specimens were collected in Zambia on Mount Makulu in 1965, and in the Kafue Gorge, Mazabuka District, in 1972. Probably significantly more widespread in both countries than indicated on the distribution map since it is often grown as an ornamental in gardens. Widely naturalized, especially on roadsides and in rocky areas (Flora of Zimbabwe, 2020), especially in the western, central and eastern regions of Zimbabwe (Maroyi, 2012).







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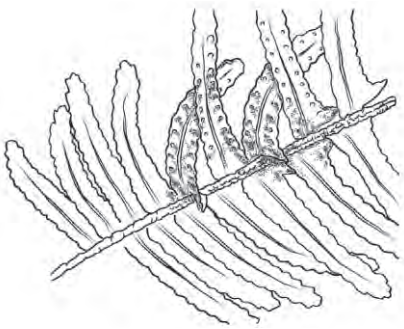
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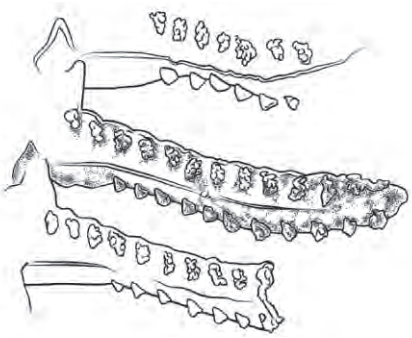
FERNS

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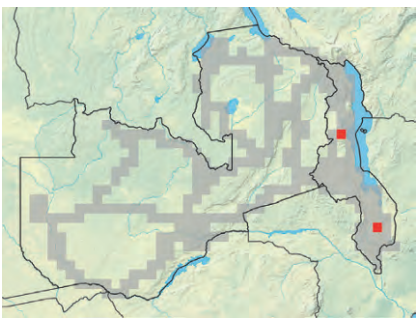
Nephrolepis cordifolia (L.) Presl











FERN FAMILY
Nephrolepidaceae

COMMON NAMES
English: Boston fern, erect sword fern, fishbone fern, ladder fern, lemon butter fern, sword fern, tuber sword fern, tuberous sword fern

DESCRIPTION
Evergreen, stiff fern up to 1 m high with small, scaly underground round to globe-shaped tubers (15 mm wide) which distinguishes it from the exotic *N. exaltata* (L.) Schott which has no tubers, and the native *N. undulata* (Afzel.) J. Sm. which has long stolons (slender stems that grow horizontally along or just above the ground), in places producing elliptical tubers (25 mm long); rhizomes (underground horizontal stems) have orange-brown to pale brown linear scales; stolons (horizontal above-ground stems) are slender and wiry, also covered in some scales.

Leaves: Pale green, once-divided upright or drooping fronds (50–100 cm long and 6 cm wide) with 40–100 pairs of rectangular to lance-shaped leaflets [10–35 (–60) mm long and 4–11 mm wide] with irregularly and often finely obtuse or rounded teeth on margins, touching or overlapping; leaf stalks 15–20 cm long covered in pale brown scales.

Flowers: No flowers.

Fruits: Brown (1–1.5 mm long), round to kidney-shaped spots called sori (spore containing structures) on underside of leaflets between the leaflet midvein or centre and margin.

ORIGIN
Tropical and subtropical regions of the world including Australia.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, roadsides, urban open space, coastal vegetation, forest edges/gaps and plantations.



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IMPACTS

Very popular garden plant that has escaped cultivation and formed dense stands in natural vegetation, displacing native species (Langeland *et al.*, 2008; ISSG, 2015). Spreading by means of spores, but also by stolons (creeping stems) and tubers, it has the ability to form large stands in partial, and in some cases also full shade. Adapted to growing in a variety of soil types, it also tolerates full sun, is drought resistant, and spreads rapidly in moist gardens (Rushing, 2006; SDFS, 2014). The underground tubers are very hard to remove from the soil. Naturalized in Florida (Nauman, 1981) and Georgia in the USA (Duncan and Kartesz, 1981). Also, widely naturalized in Africa, temperate Asia, New Zealand and Macaronesia (USDA ARS, 2011). In Australia it is naturalized in Victoria, in south-western Western Australia, on Norfolk Island, and outside of its natural range in the coastal regions of central New South Wales (Environmental Weeds of Australia, 2016). Possibly also naturalized on Lord Howe Island, and some areas outside its natural range in south-eastern Queensland and north-eastern New South Wales (Environmental Weeds of Australia, 2016). In South Africa it invades swamp, forest, forest margins, plantations and coastal bush (Henderson, 2020).

Notes: Despite not being actively recorded during surveys it is known to be a popular ornamental in gardens throughout Malawi and Zambia, and has occasionally escaped cultivation and established dense stands in adjoining areas. According to Phiri (2005) it is present in eight of the nine provinces in Zambia. Naturalized in Zimbabwe (Flora of Zimbabwe, 2020).











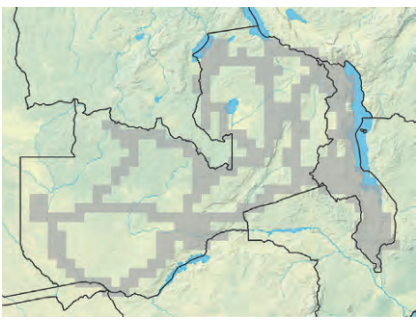
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Pteridium aquilinum (L.) Kuhn









BRACKEN FAMILY
Dennstaedtiaceae

COMMON NAMES
English: bracken fern
Vernacular: chitambala, katambala

DESCRIPTION
Evergreen herb with a large underground rhizome (belowground creeping stem) which can extend for many metres, sending up new clonal shoots.

Leaves: Yellowish-green to medium green turning brown in autumn, large roughly triangular fronds (0.3–1 m high and 15–45 cm wide), leaf blade is three times compound (divided into leaflets, which are further divided into leaflets, which are further divided into leaflets), with up to 12 leaflets along the main leaf stem and up to 15 pairs of sub-leaflets per leaflet, hairless above, hairless to sparsely hairy below; leaf stalk attached to the rhizome.

Flowers: None.

Fruits: Reproductive structures (indusia, sporangia), which contain spores are located along rolled margins on the underside of leaves.

ORIGIN
Temperate and tropical regions on all continents as well as oceanic islands. **Native to Malawi and Zambia**

REASON FOR INTRODUCTION
Native to Malawi and Zambia.

INVADES
Disturbed areas, roadsides, plantations, croplands, fallow land, riparian vegetation, forest gaps/edges, and grasslands.



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IMPACTS

Has the ability to form large stands, displacing other species. Affecting many farmers all over the world, with lost opportunity costs associated with the invasion of productive grazing land, veterinary costs associated with poisoning and tumours, ticks and associated disease problems and direct bracken control costs (CABI, 2020). In the United Kingdom, it is a weed of grasslands and forestry, and is increasing in the uplands and is difficult to eradicate (Grime *et al.*, 1998). Mature fronds of bracken fern are also poisonous to horses and cattle (CABI, 2020). Sheep have been poisoned experimentally, but natural poisoning is not common. There is unproven speculation that drinking water taken from catchments that are predominantly covered with *P. aquilinum* may contain carcinogens or other toxins that are harmful to human health (CABI, 2020).

Notes: This is a native species so it was not actively recorded during surveys. According to Phiri (2005) it is known to be present in North-western, Copperbelt, Northern, Central and Lusaka Provinces in Zambia. The first herbarium specimen collected in Malawi was in 1966 in Nyika National Park with other specimens subsequenty collected at Lichenya on Mulanje Mountain, and Zomba Mountain in Zomba District. Abundant in Nyika National Park and Mount Mulanje Forest Reserve forming extensive stands.









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HERBS

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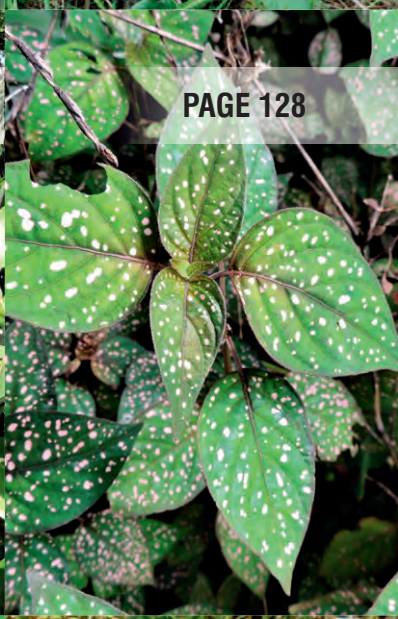






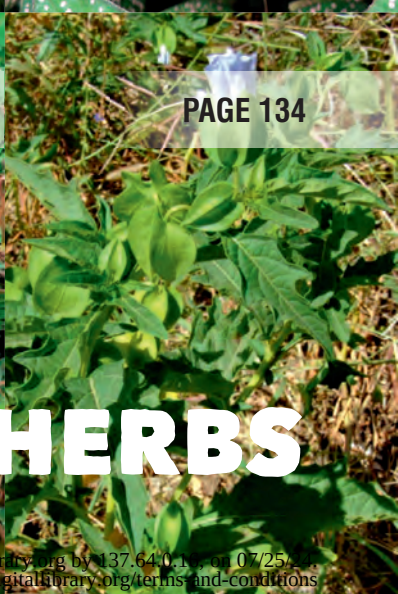












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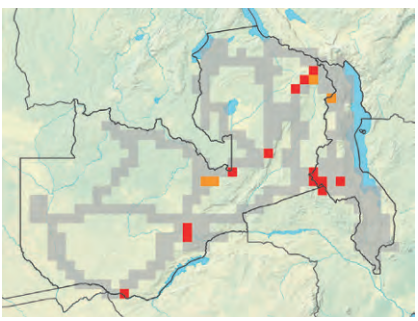
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Acmella radicans (Jacq.) R.K. Jansen.









DAISY FAMILY
Asteraceae

COMMON NAMES
English: white spot-flower plant

DESCRIPTION
Erect short-lived or annual herb [(6–) 30–90 cm tall]; stems green to purple, rarely rooting at the nodes, circular in cross-section, minutely hairy with few upright branches.

Leaves: Green, simple, egg- to widely rectangular in shape [1–7 (–12) cm long and (0.5–) 1–3.5 (–7) cm wide] with pointed terminal ends and blunt bases, margins with slightly sharp teeth and minutely hairy, 3 main veins from base, held opposite each other on stems; short leaf stalks [(0.4–) 1–2.5 (–3.7) cm long], slightly hairy.

Flowers: White to greenish-white in compact flower heads (8–12 mm long and 4–6 mm wide), cone-like, sometimes semi-round, axillary or terminal; flower head stalks 1.5–7 cm long, slightly hairy.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (2–2.5 mm long and 1 mm wide), black, hairless to hairy, margins fringed with hairs, pappus consisting of 2 fine bristles.

ORIGIN
Central and South America.

REASON FOR INTRODUCTION
Medicinal.

INVADES
Disturbed land, fallow cropland, roadsides, wastelands, and urban open space.

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IMPACTS

Details on the negative impacts of this species are lacking. However, it has been recorded as invasive in India (Reddy, 2008; Rana and Rastogi, 2017) and naturalized in China (Wang *et al.*, 2015).

Notes: Invasive in many parts of Zambia and Malawi, especially along roadsides, and other disturbed areas. According to the Flora of Malawi (2020) it is naturalized in Malawi, especially in lawns and disturbed ground. In Zambia it is "one of the most widespread and common ruderals in the country, often exceeding *Ageratum conyzoides* in abundance" (Flora of Zambia, 2020). Also recorded in North Luangwa National Park (Flora of Malawi, 2020). Naturalized in "disturbed ground" in Zimbabwe (Flora of Zimbabwe, 2020). Difficult to distinguish from other herbs during roadside surveys, especially outside of the flowering season. As such we are of the opinion that it is significantly more widespread than indicated on the distribution map.



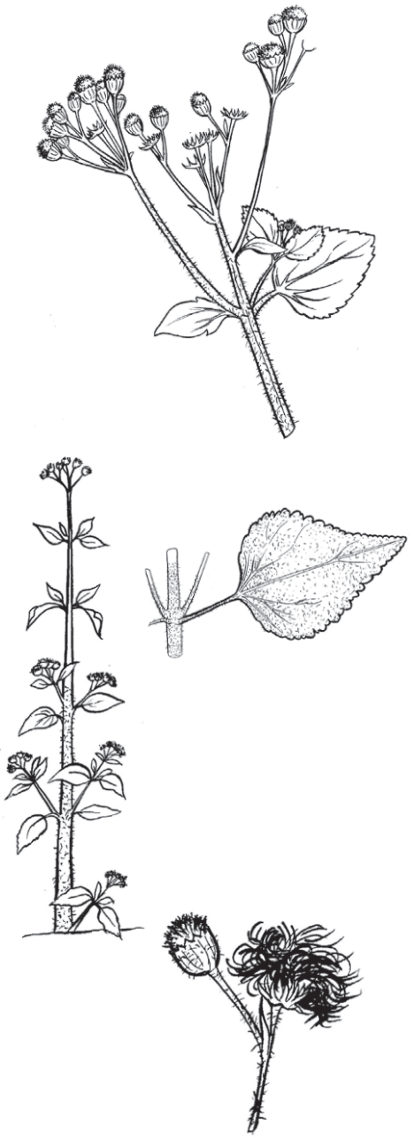


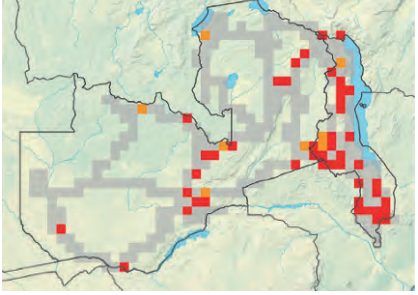




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Ageratum conyzoides L.





DAISY FAMILY
Asteraceae

COMMON NAMES
English: goatweed, invading ageratum, Mexican ageratum
Vernacular: kafwaya, kapanthe, ntawetawe

DESCRIPTION
Annual herb [0.3–1 (–1.5) m tall] with fluffy flowerheads and green, purplish or reddish stems covered with short white hairs on young parts and nodes; shallow fibrous roots.

Leaves: Bright green, sparsely hairy, rough with prominent veins, triangular to egg-shaped (20–100 mm long and 5–50 mm wide), margins bluntly toothed with blunt or pointed tips, held in opposite pairs on stem, hairy leaf stalks (5–75 mm); characteristic odour when crushed, likened to the smell of a male goat.

Flowers: Blue to lavender, sometimes with a white head, in compact terminal flowerheads bearing 4–18 flowers (4–5 mm across and 4–6 mm long), with slender, hardly exserted styles (as opposed to its congener *Ageratum houstonianum* Mill., which has longer, thicker exserted styles in heads about 6–9 mm across); slightly aromatic.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown to black, ribbed.

ORIGIN
Central and South America and West Indies.

REASON FOR INTRODUCTION
Accidentally as a contaminant and ornament.

INVADES
Roadsides, railways, disturbed land, wasteland, urban open spaces, fallow land, croplands, plantations, managed pasture, drainage ditches, forest edges/gaps, grasslands, natural pasture, riparian areas, lowlands, wetlands and coastal dunes.

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IMPACTS

This weed is allelopathic and so readily displaces native plant species. It excludes native grasses and medicinally important plants, reduces native plant abundance, and creates homogenous monospecific stands (Dogra *et al.*, 2009). In Hawaii, it threatens the survival of native species, including *Brighamia insignis* A. Gray (Campanulaceae) (Centre for Plant Conservation, 2004, in CABI, 2016). It also reduces crop yields (Kohli *et al.*, 2006), while serving as an alternate host for a number of economically destructive crop pathogens and nematodes. In cultivated lands in the lower Shivalik range of the Himalayas, infestations are so severe that farmers may have to abandon their fields (Kohli and Batish, 1996). According to Manandhar *et al.* (2007) infestations can reduce rice yields by 25% to 47%. It is a human allergenic and a health hazard (Sankaran and Suresh, 2013). In Tigray, northern Ethiopia, accidental consumption of the seeds with sorghum has been implicated in the deaths, from liver disease, of 27 people and numerous livestock (Desta *et al.*, 2014).

Notes: Widespread in Malawi and Zambia, especially in disturbed areas such as roadsides, urban open space, and fallow lands. Probably significantly more abundant in both countries than indicated. Found in "disturbed places, abandoned cultivation, open woodland and along streams and seepage zones in Malawi and Zambia" (Flora of Malawi, 2020; Flora of Zambia, 2020). An herbarium specimen was collected in 1933 along the banks of the Shire River, Nsanje District, followed by a specimen collected in 1993 from Chisongoli Forest Reserve, Mulanje District. In Zambia it has been recorded in North-western, Northern, Central, Lusaka and Southern Provinces (Phiri, 2005). Also recorded in dambos in North Luangwa National Park (Smith, 1998) and in South Luangwa National Park, Zambia (Astle *et al.*, 1997). In Zimbabwe it is invasive throughout the country (Maroyi, 2012).







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Ageratum houstonianum Mill.



DAISY FAMILY
Asteraceae

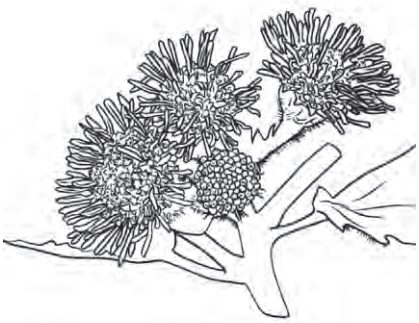
COMMON NAMES
English: goatweed, invading ageratum, Mexican ageratum
Vernacular: kafwaya, kapanthe, ntawetawe

DESCRIPTION
Annual herb [0.3–1 (–1.5) m tall] with fluffy flowerheads; stems green, purplish or reddish softly hairy.

Leaves: Bright green, sparsely hairy, rough with prominent veins, triangular to egg-shaped or oval (2–7 cm long and 1.5–6 cm wide), broader at the base and tapering towards the end, margins bluntly toothed with blunt or pointed tips, in opposite pairs on stalks (0.5–3 cm long); in *A. houstonianum* leaf base is heart-shaped or appears to end abruptly as if cut off squarely but this is never so in *A. conyzoides*.

Flowers: Blue to mauve, slightly aromatic, in compact terminal flowerheads (5–8 mm across), showing longer, thicker exserted styles (the elongated, slender female part of a flower connecting the ovary to the stigma).

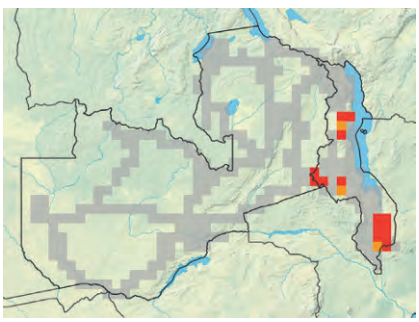
Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), black or brown (2 mm long).



ORIGIN
Central and South America and West Indies.

REASON FOR INTRODUCTION
Accidentally as a contaminant and ornament.

INVADES
Roadsides, railway lines, disturbed land, fallow land, cropland, plantations, gardens, drainage ditches, forest edges/gaps, woodlands, woodland edges/gaps, grasslands, wetlands and lowlands.



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IMPACTS

Impacts are similar to those of *A. conyzoides*. Abundant and widespread especially along roadsides, in the understory of forestry plantations, croplands and urban open space. In Australia it invades natural vegetation "resulting in substantial changes in native plant communities" displacing native plants and animals (Environmental Weeds of Australia, 2016). *A. houstonianum* has invaded "relatively intact open forest vegetation within Brisbane Forest Park" and is locally abundant on coastal hind-dunes and headlands in New South Wales, including conservation areas (Environmental Weeds of Australia, 2016). In South Africa it has invaded a range of habitat types displacing other plant species. In Hawaii it is common in disturbed habitats, especially along trails and roadsides (Wagner *et al.*, 1999). It is naturalized on Fiji especially "along roadsides, on river banks, and on cleared upland slopes and crests" (Smith, 1991). Like its congener, the plant contains "an alkaloid, pyrrolizidine, which causes liver lesions and tumours if ingested by grazing animals" (Sankaran and Suresh, 2013).

Notes: Locally abundant in Malawi, especially in disturbed areas. No records for Zambia, based on our surveys, but this is probably an oversight. According to the Flora of Zambia (2020) it has been recorded as a weed along "roadsides, areas of disturbed ground and by streams." An herbarium specimen was collected in Malawi in 1965 at Sadzi, near Zomba, with another specimen collected in 1972 in Blantyre. In Zimbabwe *A. houstonianum* has been recorded as naturalized in the central and eastern regions (Maroyi, 2012) where it occurs in disturbed sites and along streams and rivers (Flora of Zimbabwe, 2020).







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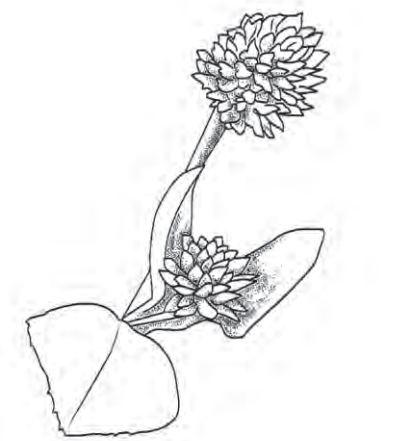
Alternanthera brasiliana (L.) Kuntze



AMARANTH FAMILY
Amaranthaceae

COMMON NAMES
English: alternanthera, Brazilian joyweed, calico plant, indoor clover, Joseph's coat, joy weed, large purple alternanthera, metal weed, parrot leaf, purple alternanthera, purple joy weed, purple joyweed, ruby calico plant, ruby leaf, ruby leaf alternanthera

DESCRIPTION
An erect, herbaceous plant or sub-shrub [(60–) 1–3 m tall], short- or long-lived, many-branched; stems rounded with longitudinal ridges, maroon in colour.

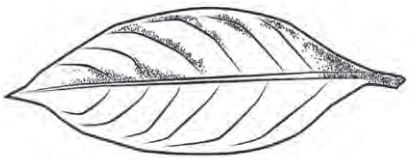


Leaves: Usually maroon in full sun but dull greenish in shade, soft, smooth, narrowly egg- to lance-shaped [3–8 cm long and 1–2.5 (–5) cm wide], ending in a long-pointed tip, base wedge-shaped to rounded; leaf stalk relatively short (0.3–1 cm long).

Flowers: Greenish-white in round pea-shaped heads (0.7–1 cm high) on stalks (3–10 cm long), about 60 flowers in each head with each individual flower stalk up to 2 mm long.

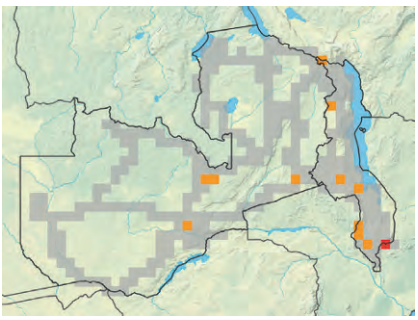
Fruits: Utricle (a dry, thin-walled fruit with a free single seed), initially green, turning brown and becoming dry and tough.

ORIGIN
Belize, Brazil, Colombia, Ecuador, French Guiana, Guatemala, Guyana, Mexico, Nicaragua, Peru, Surinam, Venezuela. and the Caribbean.



REASON FOR INTRODUCTION
Food, medicine and ornament.

INVADES
Roadsides, disturbed land, fallow land, urban open space, closed-canopy forest, and stream banks.



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IMPACTS

Forms dense stands, smothering and out-competing native plant species thereby threatening ecosystems (Willan, 2014). Known to cause dermatitis and asthma in some people (Willan, 2014). It has escaped cultivation and is now naturalized in several parts of Australia mainly colonizing waterways in the warmer and wetter coastal areas of northern Australia. Also regarded as an environmental weed in Queensland and the Northern Territory (Environmental Weeds of Australia, 2016) where it is seen as a threat to native plant ecosystems. It has also been found to be invasive in several Pacific islands (PIER, 2010). This species is also listed as an invasive plant in the Kruger National Park in South Africa and Florida, USA (Willan, 2014). Also considered to be naturalized in India, Hawaii, Niue, Pitcairn Islands, Cook Islands, French Polynesia, Palau, and Singapore (Graham Brown, *pers. comm*. in Willan, 2014).

Notes: Naturalized along roadsides in Malawi and Zambia but probably far more widespread than indicated. Not included in Flora Zambesiaca and there are no known herbarium specimens in Malawi. Considered to be naturalized in Zimbabwe (Flora of Zimbabwe, 2020) together with its congeners *A. caracasana* Kunth., *A. nodiflora* R.Br., *A. pungens* Kunth. and *A. sessilis* (L.) DC. (Maroyi, 2012).







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Argemone mexicana L.







POPPY FAMILY
Papaveraceae

COMMON NAMES
English: Mexican poppy, Mexican thistle, prickly poppy
Vernacular: lilaka lang'ombe, matitidza, mkumajalaga

DESCRIPTION
Annual, very spiny herb (to 0.9 m high); stems exude a yellow sap when damaged.

Leaves: Grey or bluish-green with prominent white veins and a yellow mid-vein (5–22 cm long and 3–7 cm wide), 7–12 deep lobes, margins spiny/prickly; leaves of *A. ochroleuca* are a darker shade of green.

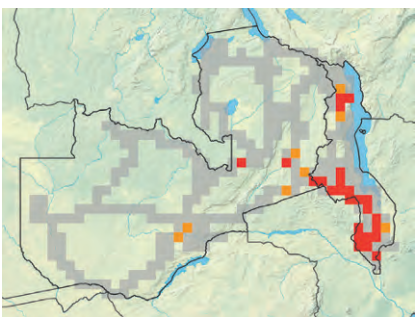
Flowers: Bright yellow (2.5–5 cm across), as opposed to pale yellow or creamy white in *A. ochroleuca*.

Fruits: Capsules (dry fruits that open at maturity), spiny, green turning brown as they mature, egg-shaped (2.5–4 cm long), splitting into (3–) 5 (–6) lobes, releasing small black seeds (1.5 mm across).

ORIGIN
Florida, Mexico, Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Guyana, Venezuela, Brazil, Bolivia, Colombia, Ecuador, Peru, Paraguay, Uruguay and the Caribbean.

REASON FOR INTRODUCTION
As a contaminant.

INVADES
Roadsides, railway lines, disturbed land, wasteland, urban open spaces, fallow land, cropland, managed pasture, riparian areas, gullies and dry river courses.



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IMPACTS

Reduces plant diversity and has an inhibitory effect on germination and seedling growth in vegetables (Hazarika and Sannigrahi, 2001). Weed residues may also affect the growth and development of bambara groundnut and sorghum (Karikari *et al.*, 2000). Ingestion of seeds by poultry can result in death. Grazing animals can be poisoned if they consume the weed in hay or chaff. Harvesting of crops infested with this weed can also result in injuries. Edible vegetable oil either accidentally contaminated with *A. mexicana* or intentionally adulterated by unscrupulous traders has resulted in epidemic dropsy in India. An epidemic also occurred in South Africa following the contamination of wheat flour (Sharma *et al.*, 1999). *A. mexicana* has been identified as a serious allergen in India (Singh and Kumar, 2004).

Notes: It is difficult, during roadside surveys, to differentiate between *A. mexicana* and *A. ochroleuca*, so their distributions are grouped together. Both species are probably far more widespread than indicated in the distribution map. According to Flora Zambesiaca, a specimen was collected in Malawi in 1919. There is also a record in Williamson (1954) from "the Fort Johnson District lakeshore". Herbarium specimens were collected in Chikwawa in 1963, Dedza (1964 and 1968), and Salima Districts (1968), all in Malawi. Present in North-western and Eastern Provinces of Zambia (Phiri, 2005) where it is "a weed of waste land, disturbed sites and sandy river beds" (Flora of Zambia, 2020). It has also been recorded in riverbeds in South Luangwa National Park, Zambia (Astle *et al.*, 1997). Recorded as invasive throughout Zimbabwe (Maroyi, 2012).









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Argemone ochroleuca Sweet







POPPY FAMILY
Papaveraceae

COMMON NAMES
English: Mexican poppy, prickly poppy, Mexican thistle, yellow poppy

DESCRIPTION
Annual, very spiny or prickly herb (30–100 cm tall); stems covered with stiff yellowish prickles which exude a yellow sap when damaged.

Leaves: Bluish-green with prominent white veins and a yellow mid-vein (7–15 cm long and 2–6 cm wide), 7–12 lobes, margins spiny/prickly; leaves of *A. mexicana* are a greyer-green.

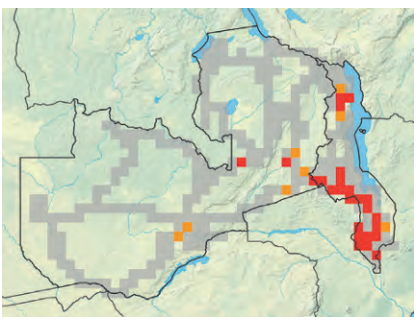
Flowers: Pale yellow or creamy white (3–7 cm across), as opposed to bright yellow in *A. mexicana*.

Fruits: Capsules (dry fruits that open at maturity), initially green turning brown as they mature, spiny, elongated with almost parallel sides (25–45 mm long and 12–18 mm wide), splitting into 5 lobes or compartments, releasing small black seeds.

ORIGIN
Mexico and West Indies.

REASON FOR INTRODUCTION
As a contaminant.

INVADES
Roadsides, railway lines, wasteland, disturbed land, urban open spaces, fallow land, cropland, managed pasture, savannah and dry river courses.



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IMPACTS

Forms large and dense infestations, especially in disturbed areas, where it crowds out other species. It alters the structure, not only of native plant communities, but also of their associated fauna (Moussa and Muneera, 2012). In Australia, it is found in seasonal creeks, stream beds, drainage lines and disturbed areas, where it competes with native species and restricts the movement of animals, often causing injury (Smith, 2002; Weber, 2003). It is a major invasive weed of vegetable and crop fields (Holm *et al.*, 1977), reducing yields of cereals such as wheat (Rawson and Bath, 1981). However, in Australia, both *A. ochroleuca* and *A. mexicana* are not considered to be particularly aggressive competitors of crops or established pastures, persisting only until the crop or perennial species become established, then gradually disappearing (Parsons and Cuthbertson, 1992). Similar to its congener, *A. mexicana*, it is also highly toxic to humans and has contributed to many deaths, especially when consumed in contaminated mustard oil (Babu *et al.*, 2007). The plant is unpalatable and as such rarely consumed by livestock, but plant material, including seeds, mixed with hay or grain may poison animals if consumed (Holm *et al.*, 1977). Other impacts are assumed to be similar as those recorded for *A. mexicana*.

Notes: It is difficult, during roadside surveys, to differentiate between *A. mexicana* and *A. ochroleuca*, so their distributions are grouped together. Both species are probably considerably more abundant and widespread in both countries than indicated in the distribution map. According to Flora Zambesiaca *A. ochroleuca* was first recorded in Malawi in 1919. In Zimbabwe it is "a weed of waste land, disturbed sites and sandy river beds" (Flora of Zimbabwe, 2021).







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Canna × *generalis* L.H. & E.Z. Bailey







CANNA FAMILY
Cannaceae

COMMON NAMES
English: canna, canna lily, common garden canna, Indian shot

DESCRIPTION
Robust, evergreen herb (1–2 m high) with a thick, branching, underground rhizome (horizontal root-like stem).

Leaves: Purple-bronze, hairless, simple, elongated or oval (20–60 cm long and 10–30 cm wide), tapering to a point, margins entire; leaf stalks slender, forming a sheath (tubular structure that clasps the stem); similar to *C. indica* L. which has green leaves.

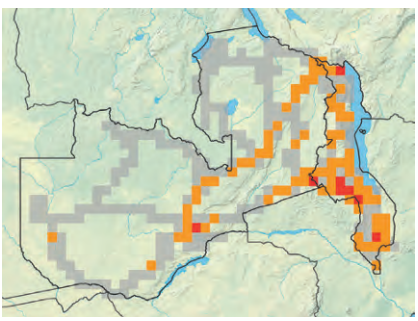
Flowers: Yellow, red, orange, white, or in other colours, five false 'petals', broad (15–55 mm wide), arranged in larger, branched clusters of 6–20 flowers at the ends of flowering stems.

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, spiny, three-valved, containing hard black seeds (0.5 cm wide).

ORIGIN
Ornamental cultivar with origins in Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, urban open spaces, gardens, drainage ditches, irrigation channels, dam edges, forest edges/ gaps, lowlands, wetlands and watercourses.



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IMPACTS

Like *C. indica*, this *Canna* hybrid has the ability to form dense stands in moist lowland areas, displacing native plant species and the organisms associated with them. Other impacts are assumed to be similar to those recorded for *C. indica*.

Notes: Widely grown as an ornamental in Malawi and Zambia it has escaped from gardens and established along some waterways. Significantly more invasive in Malawi than Zambia.









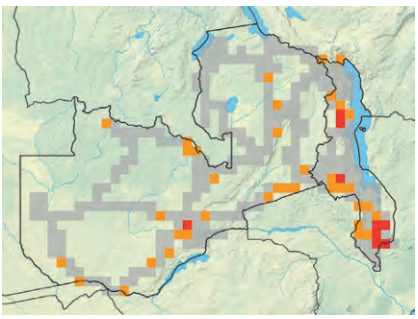
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Canna indica L.









CANNA FAMILY
Cannaceae

COMMON NAMES
English: African arrowroot, canna lily, edible canna, Indian shot, purple arrowroot
Vernacular: chikasu

DESCRIPTION
Robust evergreen herb (1–2 m high) with a thick, branching, underground rhizome; leaves taper into slender leaf stalks that form a sheath (clasping tubular structure) around the main stem.

Leaves: Green, hairless, simple, elongated or oval (20–60 cm long and 10–30 cm wide), tapering to a point, margins entire, stem-clasping sheath similar to *C.* × *generalis* Bailey which has purple-bronze leaves.

Flowers: Red or orange, usually yellow below, five false 'petals', narrow (40–50 mm long), held singly or in pairs, arranged in larger branched clusters of 6–20 flowers at the ends of flowering stems; in *Canna* × *generalis*, flowers are yellow, red, orange, white or in other colours, broad (80–90 mm long).

Fruits: Capsules (dry fruits that open at maturity), green turning brown as they mature, spiny, three-valved, containing hard black seeds (0.5 cm wide).

ORIGIN
Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, urban open spaces, gardens, plantations, drainage ditches, irrigation channels, forest edges/gaps, dam/lake/river edges, ponds, lowlands, floodplains, swamps and wetlands.

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IMPACTS

Forms dense clumps, out-competing native plant species. It also restricts the flow of water, contributing to increased sedimentation and flooding. Dense stands can also restrict access to water. In Hawaii, USA, it has become naturalized mainly in disturbed mesic to wet forest, and in Fiji it is naturalized in coconut plantations, in clearings, and near streams in forests (Smith, 1979). In Australia it is considered to be an environmental weed forming "large dense clumps, particularly along waterways" where it "replaces native aquatic and wetland species" (BCC, 2016). According to Binggeli (1997), it is one of the main invasive species on Pitcairn Island where it forms large monotypic stands. It is an alternative host of a number of crop pests, including banana bunchy top virus, cucumber mosaic virus and tomato spotted wilt virus, and a range of other pests that cause pathogenic diseases. Chemical extracts have a negative impact on snail species (Tripathi and Singh, 2000).

Notes: Grown in many gardens in Malawi and Zambia it has escaped cultivation and established in wetlands, swamps, and low-lying areas where there is sufficient soil moisture. Also recorded as invasive in areas surrounding Mount Mulanje Forest Reserve (Shah and Makhambera, 2019). According to Flora Zambesiaca, *C. indica* was seen along a streambank in Misuku, Chitipa District, in 1952, and on the Phalombe Plain in Mulanje District in 1956. Herbaria in Malawi have specimens collected along the Mulunguzi River in Zomba and Kalulu Forest Reserve in Thyolo District. In Zambia it has been recorded in riparian vegetation in Lusaka (Sikatala *et al.*, 2019). In Zimbabwe, it is "persistent in disturbed ground, and also in wet places such as by streams and in ditches" (Flora of Zimbabwe, 2020); naturalized in the central, eastern and southern regions (Maroyi, 2012).





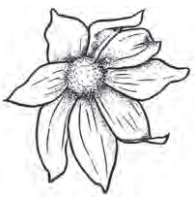




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Dahlia imperialis Roezl ex Ortgies









DAISY FAMILY
Asteraceae

COMMON NAMES
English: bell tree dahlia, candelabra dahlia, giant dahlia, imperial dahlia, tree dahlia

DESCRIPTION
Evergreen fast-growing herb (2–6 m tall); stems erect, 4-angled, brittle and woody (8 cm wide), usually branched from the base with swollen nodes and with underground tubers (a swollen underground stem that functions as a food storage organ or as a means of vegetative production).

Leaves: Bright green, veins on upper surfaces covered with short fine hairs, with a scattering of long, soft hairs below, large, twice-divided (35 cm long); leaflets are egg-shaped with broader, rounded bases tapering towards the end, margins with forward-pointing sharp projections or teeth, leaves held opposite each other on the stems.

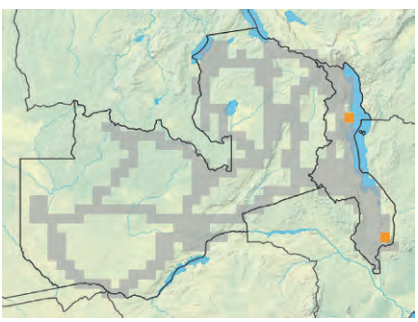
Flowers: Pink or purple with a yellow core, large (75–150 mm wide), pendulous, solitary or paired in the axils of the upper leaves, showy.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (13–17 mm long).

ORIGIN
Mexico and possibly Colombia and Guatemala and elsewhere in Central and South America.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, gardens, plantations and forest gaps/edges.



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IMPACTS

Forms dense stands which may displace native fauna and flora. Parts of the plant are considered to be toxic.

Notes: Not common in Malawi or Zambia but probably more widespread as an ornamental than indicated on the distribution map. Found to have escaped cultivation at an overnight hut on Mount Mulanje. Highly invasive in *Eucalyptus* and *Pinus* plantations in southern Tanzania, but also elsewhere in Tanzania and Kenya (Witt *et al.*, 2018). Not known to be naturalized or invasive in Zimbabwe (Maroyi, 2012; Flora of Zimbabwe, 2020). A congener *D. pinnata* Cav. is recorded as a casual alien in the central region of Zimbabwe (Maroyi, 2012).





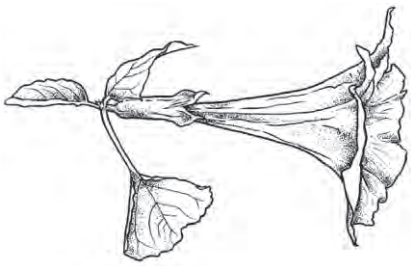




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Datura innoxia Mill.







SYNONYM
Datura meteloides DC. ex Dunal

TOMATO FAMILY
Solanaceae

COMMON NAMES
English: downy thorn apple, Indian-apple, moonflower, pricklyburr, recurved thorn-apple
Vernacular: mkalabwinji, namasika

DESCRIPTION
Annual trailing or bushy herb (to 2 m high), softly grey-velvety on all parts; glandular hairs cover the stems and leaves, making it clammy to the touch.

Leaves: Grey-velvety turning dark green and less velvety, veins prominent; oval (to 20 cm long), margins entire to shallowly toothed, held alternately on stem on long leaf stalks; bad-smelling when crushed or bruised.

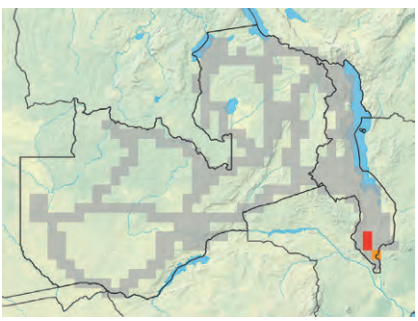
Flowers: White, solitary, tubular or trumpet-like, large (20 cm long and 12 cm wide), green veins.

Fruits: Capsules (dry fruits that open at maturity), brown, hardened, round (30–50 mm long), densely covered with slender spines about 1 cm long unlike *D. metel* where the capsule is more warty than spiny, hanging downwards from the plant; brown seeds (4–5 mm long).

ORIGIN
Belize, Guatemala, Mexico, USA and possibly elsewhere in tropical America.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, wasteland, disturbed land, fallow land, lowlands, gullies and dry riverbeds.



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IMPACTS

It readily escapes from gardens, where it has been grown as an ornamental, forming large stands to the possible detriment of native plant species. It also competes strongly with crop plants (Parsons and Cuthbertson, 1992). In Windhoek, Namibia, *D. innoxia* "is widely distributed along riverbanks, disturbed areas and around human settlements" (Joyce, 2008). As with other *Datura* species, it is toxic and may be fatal if ingested by humans and other animals, including livestock and pets (Parsons and Cuthbertson, 1992). Other impacts are assumed to be similar to those recorded for other *Datura* species.

Notes: Probably more widespread in Malawi and Zambia than indicated, with invasions recorded in southern Malawi. Recorded as invasive around Mount Mulanje Forest Reserve (Shah and Makhambera, 2019). According to Flora Zambesiaca the species was seen along the Lisungwe River in Blantyre District, Malawi, in 1970. In Zambia it is present in the Victoria Falls area (Pickering and Roe, 2009). In Zimbabwe it is a "naturalised weed of cultivated and disturbed areas" (Flora of Zimbabwe, 2020) and regarded as invasive in the northern, eastern and southern regions (Maroyi, 2012).





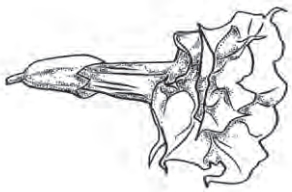




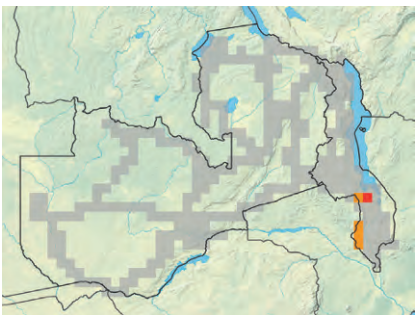
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Datura metel L.









TOMATO FAMILY
Solanaceae

COMMON NAMES
English: angel's trumpet, cornucopia, datura, devil's trumpet, downy thorn-apple, Hindu datura, Hindu thorn-apple, hoary thorn-apple, horn-of-plenty, jimson weed, metel, purple thorn-apple, thorn apple
Vernacular: lilaka langombe

DESCRIPTION
Short- or long-lived herb (0.9–1.4 m tall), hollow stems are slightly hairy with dark violet shoots; plant has strong odour.

Leaves: Green but sometimes dark violet, simple, oval to broadly oval or lance-shaped (6–12 cm long and 3–8 cm wide), entire or lobed, hairless, terminal end pointed, base oblique; leaf stalk relatively long (2–5 cm long).

Flowers: Greenish-white, yellow, red, or violet, large (15–20 cm across), single or double, solitary.

Fruits: Capsules (dry fruits that open at maturity) are initially green turning black as they mature (5 cm wide), covered with numerous conical humps and a few spines compared to *D. innoxia* which is covered by many sharp spines; seeds yellowish-brown, flattened (4 mm long and 3 mm wide).

ORIGIN
Tropical Asia.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, roadsides, wastelands, dry riverbeds, and urban open spaces.

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IMPACTS

Can form dense stands, especially in disturbed areas, inhibiting the germination and growth of other plant species. Like all other members of the *Datura* genus it contains highly toxic alkaloids. Ingestion by people of any plant part can result in narcotic, hallucinogenic, comatic, and potentially lethal effects with symptoms occuring within 30–60 minutes of ingestion (Holstege *et al.*, 2011). It can also facilitate fires as has been reported in some parts of the West Indies (Boldingh, 1909). It is invasive in Cuba (Oviedo Prieto *et al.*, 2012), the Galapagos Islands, Micronesia, Fiji, French Polynesia, Kiribati, New Caledonia, the Seychelles, Niue, China, and Taiwan (Randall, 2012) and is a principal weed in Ghana and India (Holm *et al.*, 1979).

Notes: Has escaped cultivation in a few areas, and is now established along some dry riverbeds and disturbed areas near the shores of Lake Malawi. Not recorded in Zambia but it may have been missed during surveys. According to Flora Zambesiaca the species was first recorded near Magomero, south of Zomba, Malawi, in 1861. The first herbarium specimen in Malawi was collected in 1970 along the Lisungwe River in Blantyre District, followed by another collection in 1978 in Chikwawaw, south of Blantyre.





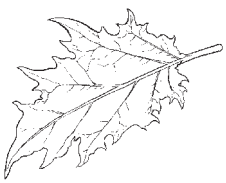


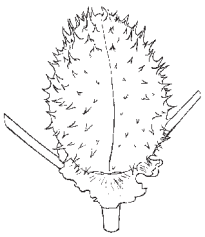
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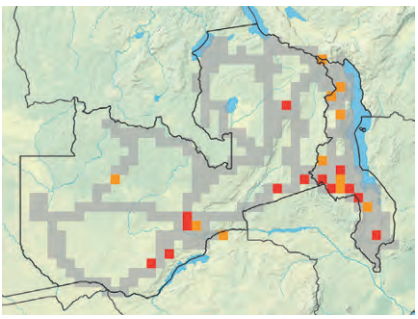
Datura stramonium L.











SYNONYMS
Datura hybrida Ten.; *Datura inermis* Juss. ex Jacq.

TOMATO FAMILY
Solanaceae

COMMON NAMES
English: common thorn apple, datura, devil's trumpet, jimson weed, moonflower, thorn apple
Vernacular: chivumulo, mkalabwinji, namasika

DESCRIPTION
Annual herb (0.5–2 m tall); stems green, purple or brown, hairy to hairless; single stem divides into two branches, both of which again divide into two branches as they grow, and so on.

Leaves: Dark green or purple, paler below, hairless, veins prominent; egg-shaped, bases broad, rounded to broadly triangular (5–25 cm long and 4–25 cm wide), margins coarsely and irregularly toothed or lobed; alternate on stems on long petioles (to 10 cm); bad-smelling when crushed or bruised.

Flowers: White, mauve or purplish, funnel-shaped (to 100 mm long), at each fork of the stem.

Fruits: Capsules (dry fruits that open at maturity), initially green turning brown as they mature, egg-shaped (3–7 cm long and 2–3.5 cm wide), covered with slender spines (to 10 mm long), held erect on the plant; seeds dark brown to black (3–4 mm long and 2–3 mm wide).

ORIGIN
Unclear, but probably tropical America.

REASON FOR INTRODUCTION
Ornament and as a contaminant.

INVADES
Roadsides, railways, disturbed land, wasteland, fallow land, crops, managed pasture, drainage ditches, woodland edges/gaps, lowlands, gullies and dry riverbeds.

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IMPACTS

Competes aggressively with native plants and crops, forming dense monospecific stands. Invasions in the USA have resulted in a 56% yield loss in cotton (Oliver *et al.*, 1991). Yields of soyabean plants growing within a distance of 1.2 m from a thorn apple plant are significantly reduced (Henry and Bauman, 1991), demonstrating the allelopathic impacts of this weed. In Spain, competition from thorn apple in irrigated maize has reduced yields by 56% (Torner *et al.*, 1995). At densities of 3–11 plants per m^2, yields of tomatoes may be reduced by 26–71% (Monaco *et al.*, 1981). *D. stramonium* is also an alternative host for several pests and pathogens of solanaceous crops. Toxic to people, horses, cattle, sheep, pigs and chickens (Watt and Breyer-Brandwijk, 1962), thorn apple has gained notoriety as a plant that is used by people to commit suicide. Between 1950 and 1965, 2,775 human deaths have been attributed to ingestion of this weed (Freye, 2010).

Notes: More than 60 years ago *D. stramonium* was considered to be a common weed in Malawi (Williamson, 1954). We suspect that it is still widespread, especially in disturbed areas, but probably under-recorded in our surveys. According to Flora Zambesiaca, *D. stramonium* has also been collected from Blantyre and Ntcheu Districts in Malawi. The first herbarium specimen collected in Malawi was in 1956 at the Chitedze Agricultural Research Station near Lilongwe. Other specimens were collected in 1967 at Chongoni Forest Reserve in Dedza District and in 1970 in Blantyre District. Present in Lusaka, Southern and Western Provinces of Zambia (Phiri, 2005) and invasive throughout Zimbabwe (Maroyi, 2012).









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Desmodium intortum (Mill.) Urb.



PEA FAMILY
Fabaceae

COMMON NAMES
English: Beggarlice, green leaf desmodium, green-leaf desmodium, greenleaf desmodium, greenleaf tick trefoil, greenleaf ticktrefoil, green-leaved desmodium, tick clove
Vernacular: kalamabatila (*Desmodium* spp.), nkhunga

DESCRIPTION
A large, branched and spreading evergreen herb or sub-shrub with long trailing and climbing hairy stems (1.5 to 7.5 m long and 7 mm in diameter), green or sometimes red and longitudinally grooved, rooting at the nodes.

Leaves: Reddish-brown to purple with three leaflets, each egg-shaped (2–7 cm long x 1.5–5.5 cm wide), often with sparse reddish-brown/purplish marks on the upper surface; leaf stalk relatively long [3–5 (–9) cm long].

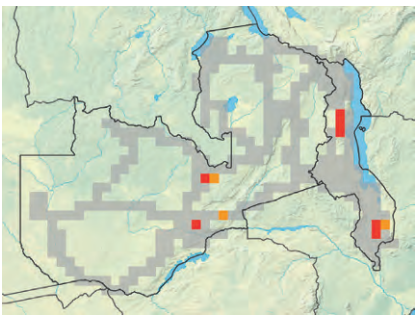
Flowers: Deep lilac to pink in compact terminal clusters (30 cm long) with two flowers at each node.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, narrow, oblong, segmented (1.5–5 cm long and 3–4 mm wide), densely covered with short, brownish, hooked hairs, containing 8 to 12 kidney-shaped seeds (3 mm long and 1.5 mm wide) that stick strongly to hair or clothing.

ORIGIN
Belize, Bolivia, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Hispaniola, Honduras, Jamaica, Mexico, Nicaragua, Panama, Peru, Puerto Rico, and Venezuela.

REASON FOR INTRODUCTION
Fodder.

INVADES
Disturbed areas, roadsides, along footpaths, moist and shaded areas.



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IMPACTS

Has the ability to climb over and smother native vegetation, reducing native plant abundance and diversity. Regarded as an environmental weed in Queensland and northern New South Wales it was "recently listed among the top 200 most invasive plants in south-eastern Queensland and is mainly a concern in riparian vegetation, due to its shade tolerance and its ability to climb over other plants" (Environmental Weeds of Australia, 2016). Also regarded as invasive in several other parts of the world (PIER, 2006; Environmental Weeds of Australia, 2016) but not considered to be as serious a weed as its congener *D. uncinatum* (Jacq.) DC. (Cook, 2008). Where it is invasive we surmise that impacts may be similar to those of its congener.

Notes: Highly likely to be more widespread, especially in wetter areas in Malawi, than indicated on the distribution map. Can often be confused with its congener *D. uncinatum*, especially during roadside surveys. The first herbarium specimens collected in Malawi were in 1933 at Malawi Hills in Nsanje District and Port Herald in Mangochi District.



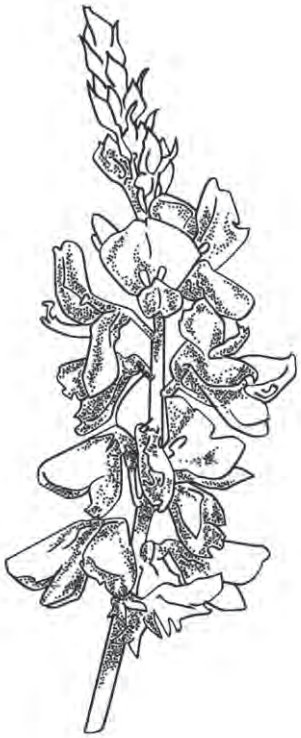






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Desmodium uncinatum (Jacq.) DC.





PEA FAMILY
Fabaceae; sub-family: Papilionaceae

COMMON NAMES
English: desmodium, silverleaf desmodium; Spanish clover, Spanish tick-clover, velcro plant, velcro vine
Vernacular: damate, kalamabatila (*Desmodium* spp.)

DESCRIPTION
Evergreen legume with long cylindrical or angular stems covered with short, hooked hairs that stick to body hair or to clothing; rooting at the nodes; strong taproot.

Leaves: Dark green above with an irregular pear-shaped silver pattern along the mid-rib or main vein; undersides lighter green and uniform with no pattern, both sides covered with whitish hairs; trifoliate with three pointed egg-shaped leaflets [7–8 (–10) cm long and 2.5–3 (–5) cm wide]; leaf stalks 2–7 cm long.

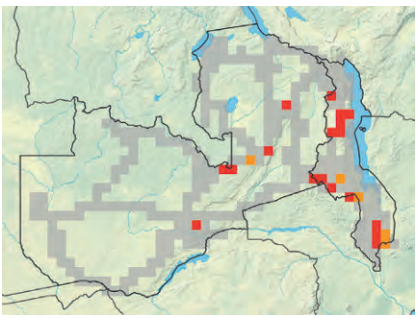
Flowers: Pale lilac to pink to bluish when mature (0.8–1 cm long), in pairs along the terminal ends of long flowering stems (to 50 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, constricted between seeds, curved (5–7 cm long), covered with short, hooked hairs; breaking into 4–8 segments when mature; seeds light brown with olive-green to cream mottling, kidney-shaped.

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Ecuador, El Salvador, Nicaragua, Paraguay, Peru, Uruguay and Venezuela.

REASON FOR INTRODUCTION
Nitrogen-fixation, fodder and ground cover.

INVADES
Roadsides, disturbed areas, along footpaths, urban open spaces, forest edges/gaps, open woodlands and riparian vegetation.



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IMPACTS

Has the ability to climb into and over vegetation, smothering plants, to the detriment of native fauna and flora. In parts of Australia, it is a weed of creek banks, roadsides, fence lines, forest margins, disturbed sites, waste areas and even plantation crops such as sugarcane. It is ranked as one of the top 100 most invasive plant species in some regions of Australia (Batianoff and Butler, 2003). There, it has reportedly "trapped" and killed native wildlife, including small frogs, birds, lizards and micro-bats, which easily become stuck in its stems and fruit. By fixing nitrogen it may also alter natural nutrient cycling processes. It is now locally naturalized in many tropical and sub-tropical parts of Africa and Southeast Asia (FAO, undated; Kretschmer *et al.*, 2001).

Notes: Widespread and abundant in Malawi and Zambia, but especially the former, where it was found to be locally abundant in higher-lying areas forming dense stands. According to Flora of Zambia (2020) it is "frequent to abundant" in Zambia, "probably in all provinces." "Frequent" in Zimbabwe, it is an "invasive escape along roadsides, at the edges of woodland or riverine vegetation and even in built-up areas" (Flora of Zimbabwe, 2020). Recorded as naturalized in the northern and central regions of Zimbabwe (Maroyi, 2012).





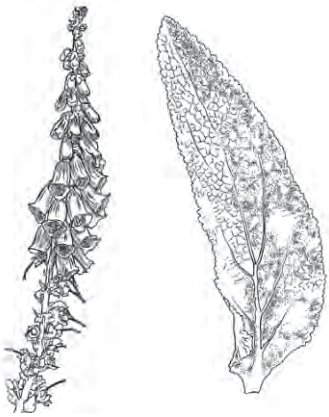




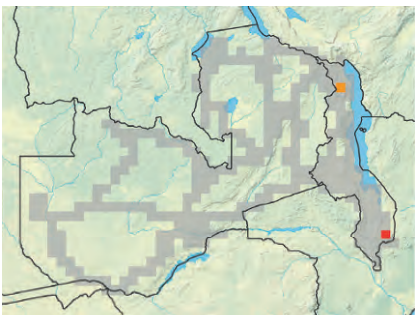
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Digitalis purpurea L.









FIGWORT FAMILY
Scrophulariaceae

COMMON NAMES
English: annual foxglove, bloody bells, bloody fingers, common foxglove, dead man's bells, fairy bells, fairy fingers, fox finger, foxglove, lady's finger, lady's foxglove, purple foxglove, thimble finger, witches bells

DESCRIPTION
Biennial (completing the full cycle of germination to fruiting in more than one, but not more than two years, and then dying) or short-lived with a basal rosette (45 to 60 cm wide) and 90–150 cm tall.

Leaves: Deep green, egg- to lance-shaped (10–35 cm long and 5–12 cm wide), soft, downy (covered with grey-white pubescent and glandular hairs) with small rounded teeth on the margins and conspicuous veins, lower leaves large, upper leaves small, spirally arranged or held on the stem; leaf stalk winged.

Flowers: Bright rosy-purple (rarely white) with white speckles inside the throats (floral tubes), thimble-like, tubular or bell-shaped (5–7 cm long), crowded at the end of a long stem (1–2 m tall), hanging down.

Fruits: Capsules (dry fruits that open at maturity); contains many tiny (0.1–0.2 mm) seeds.

ORIGIN
Belgium, Czech Republic, Denmark, Finland, France, Ireland, Italy, Morocco, Norway, Portugal, Slovakia, Spain, Sweden, and UK.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, roadsides, along footpaths and in grasslands.

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IMPACTS

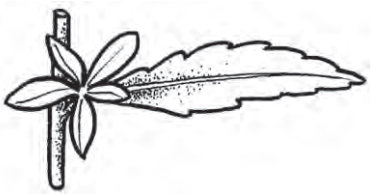
Has the ability to form dense stands, displacing native plant species. Has invaded moist and wet sclerophyll forest, riparian areas and rainforests in Victoria and Tasmania, Australia (Environmental Weeds of Australia, 2016). In Victoria, Australia, it is commonly found in conservation areas such as the Morwell National Park, Kinglake National Park and Carlisle State Park, in addition to alpine regions like Falls Creek (Environmental Weeds of Australia, 2016). Naturalized in New Zealand, Turkey, Brazil, Chile, Canada and the northern parts of USA (including Alaska). The leaves, flowers and seeds of this plant species contain the cardiac glycoside digitoxin which is poisonous to humans and some animals and can be fatal if ingested. Symptoms may include dizziness, vomiting, irregular heart-beat, and delirium or hallucinations. Contact with the sap may cause skin irritations. Not commonly eaten by animals unless very hungry, there have been a few cases of near fatal poisonings in humans where they have mistaken *D. purpurea* leaves for those of the edible herb *Borago officinalis* L. (Boraginaceae) (Bonfanti *et al.*, 2016).

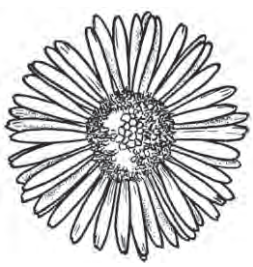
Notes: Has invaded grasslands in Mulanje Mountain Forest Reserve and more recently also Nyika National Park. Not actively recorded in Malawi or Zambia although likely to be present as an ornamental in many gardens, and possibly elsewhere in both countries.



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DAISY FAMILY
Asteraceae

COMMON NAMES
English: bony-tip fleabane, coastal daisy, erigeron, Mexican daisy, wall daisy
Vernacular: katunga mphazi

DESCRIPTION
Evergreen erect herb (50–100 cm tall) of spreading habit; woody at the base; stem greenish-purple, with white hairs.

Leaves: Dark green, simple, proximal leaves wedge-shaped, 3–5 lobed, distal leaves narrowly oval-shaped [5–30 (–50) mm long and 3–15 (–20) mm wide], with a few slightly stiffened hairs, margins entire or sometimes with two teeth (*ca.* 5 mm long); leaf stalks short (3 mm long).

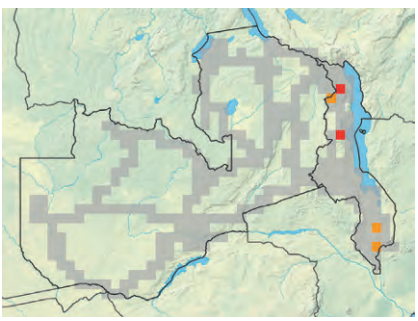
Flowers: White or pink, with yellow centres, daisy-like (7–10 mm across).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (1 mm long), tipped with hair to aid in wind dispersal.

ORIGIN
Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Venezuela.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, gardens and forest edges/gaps.



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IMPACTS

Fleabane has the ability to form extensive mats, displacing native plant and animal species. *E. karvinskianus* invades and dominates vegetation on tropical islands such as Réunion (Triolo, 2005); Ngazidja in the Comoros (Leuschner, 1996), and the Hawaiian Islands (Lorence and Wagner, 1995), where it is considered to be one of the worst invasive species. In Hawaii, it forms mats on forest floors, smothering low-growing native plant species (Motooka *et al.*, 2003), while also overrunning cliff habitats (Lorence and Wagner, 1995). In Japan, it threatens many native grasses (NIES, 2010). It is regarded as an environmental weed in New South Wales, Victoria, Tasmania and South Australia. In South Australia, it is listed as an invasive garden plant in the Greater Adelaide region, and is also present in some conservation areas.

Notes: Probably under-recorded during our surveys, especially in Zambia, where it is likely to be more common in gardens than indicated. In Malawi it has occasionally escaped cultivation, especially in higher-lying areas, such as Nyika National Park where it is considered invasive. The first herbarium specimen of this species collected in Malawi was in Malawo, Shire Highlands, Blantyre District, in 1965. Recorded as invasive in the northern, central and eastern regions of Zimbabwe (Maroyi, 2012).









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Hedychium flavescens Carey ex Roscoe





GINGER FAMILY
Zingiberaceae

COMMON NAMES
English: cream garland lily, cream ginger, cream ginger lily, wild ginger, yellow ginger

DESCRIPTION
Evergreen herbaceous plant (1.5–2 m tall) that produces a mat of large, creeping underground stems or branching rhizomes (3.5 cm wide, to 1 m thick); stems covered by hairless leaf sheaths (tubular structure that clasps stem).

Leaves: Green upper surface hairless, lower surface with some hairs (downy), somewhat elongated or sword-shaped [25–45 (–60) cm long and 5–10 (–12.5) cm wide] with a pointed base and apex tapering gradually to a sharp point, margins entire with a prominent mid-vein; held alternately on stems with a long base sheathing or surrounding the stem; not to be confused with *H. flavum*, the leaves of which are less hairy on the undersides.

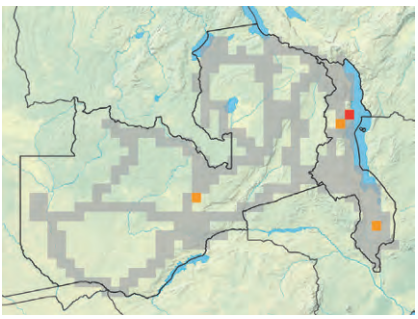
Flowers: Yellow, tubular, with three narrow and three broad petal-like lobes, darker patch on petals, held in ovoid clusters or spikes (15–20 cm long and 8 cm wide); bracts green, oval to egg-shaped (4–6 cm long and 1.5–3 cm wide); in *H. flavum* deep yellow without darker patch.

Fruits: Capsules (dry fruits that open at maturity), round (1–2 cm wide) with three compartments, rare.

ORIGIN
Eastern India, Myanmar, Nepal, southern China and Thailand.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
India and Nepal.





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IMPACTS

Has the ability to form dense monospecific stands, to the detriment of native flora and fauna. Its thick layer of underground stems and rhizomes prevents the establishment of other plant species. In New Zealand, Hawaii and La Réunion, dense invasions cover large areas, displacing native plants and preventing their regeneration. *H. flavescens* inhibits forest succession by reducing the abundance of native seedlings and saplings in the critical regeneration phase (Williams *et al.*, 2003). In New Zealand invasions may result in the permanent displacement of rare plants or specialized plant communities (New Zealand Department of Conservation). Wild ginger also alters nutrient levels and hydrological processes, affecting erosion/deposition (Williams *et al.*, 2000). It may also impact on faunal diversity and animal behaviour (Williams *et al.*, 2000). Dense invasions may prevent access to invaded areas.

Notes: Occasionally reported from gardens from where it has escaped and established in adjoining areas, especially low-lying areas with sufficient soil moisture. Only recorded as invasive in one locality in northern Malawi but likely to be more widespread than indicated. The first herbarium specimen was collected in 1971 in Karonga District, Malawi.

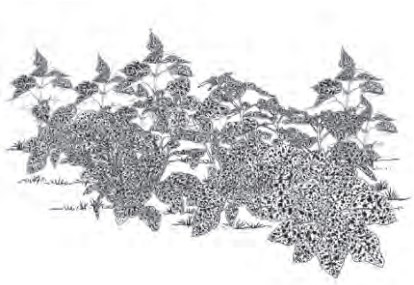


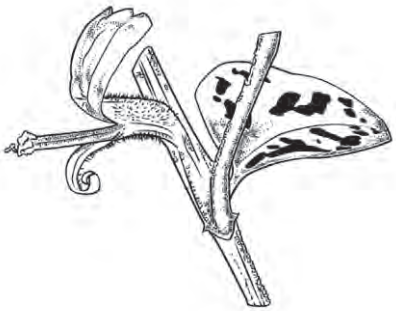


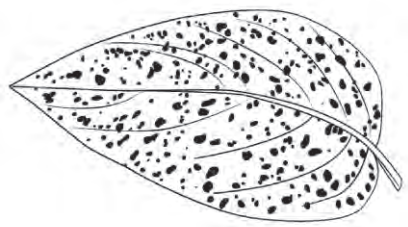


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Hypoestes phyllostachya Baker







ACANTHUS FAMILY
Acanthaceae

COMMON NAMES
English: flamingo plant, freckle face, freckle plant, freckleface, measlesplant, polka dot plant, polka-dot plant, polkadot plant, polkadot-plant

DESCRIPTION
A long-lived herb growing up to 1 m tall with four-angled stems covered in long white hairs.

Leaves: Dark green upper surfaces covered in numerous pinkish to lavender spots, undersides are paler green, both surfaces are sparsely hairy, egg-shaped or broadly lance-shaped (to 12 cm long and 8 cm wide), margins entire with pointed tips, held opposite each other along stem; leaf stalks variable (1–7 cm long).

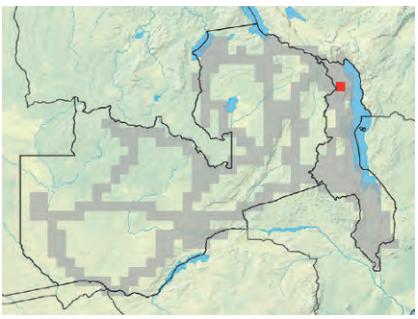
Flowers: Pink or purplish flowers (about 2 cm long), separate at the tip into two lobes, smaller lower lobe being bent backwards, borne singly in the leaf forks.

Fruits: Capsules (dry fruits that open at maturity), small (8–12 mm long), hairless, green turning brown as they mature.

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed sites, urban open space, closed forests, forest edges/gaps, riparian vegetation, and open woodlands.



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IMPACTS

Forms dense stands, especially in shaded habitats, displacing native vegetation. Widely naturalized in the coastal districts of eastern Australia (Environmental Weeds of Australia, 2016). Also naturalized on Norfolk Island and possibly naturalized in the coastal districts of central New South Wales. In south-eastern Queensland, it is listed among the top 200 most invasive plants species, and appears on numerous local environmental weed lists in this region (Environmental Weeds of Australia, 2016). Also naturalized in Hawaii and invasive in South Africa where it invades shaded and moist disturbed sites, and the margins and understoreys of forests (Henderson, 2020).

Notes: Not actively recorded during surveys so probably more widespread than indicated, especially in gardens. Recorded as invasive in an area adjoining a garden in Nyika National Park. It is not listed in Flora Zambesiaca and there are no herbarium specimens in Malawi. In Zimbabwe it is "occasionally escaping into semi-wild areas but usually not far from gardens" (Flora of Zimbabwe, 2020).







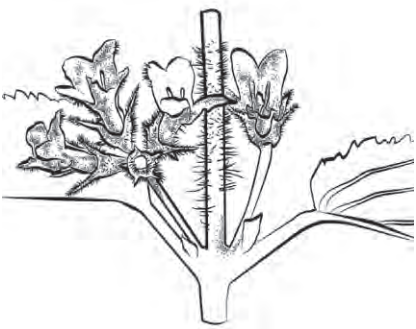


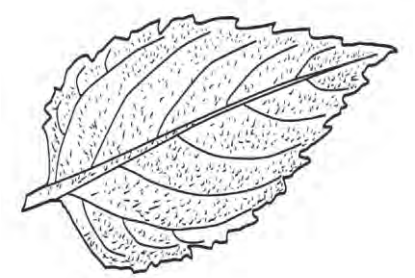


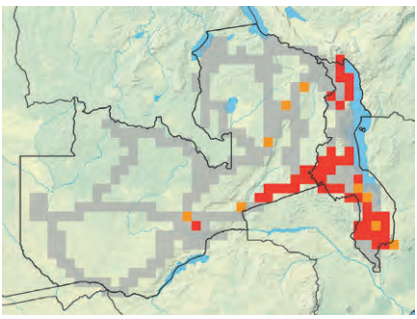
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Hyptis suaveolens (L.) Poit.









SYNONYM
Mesosphaerum suaveolens (L.) Kuntze

MINT FAMILY
Lamiaceae

COMMON NAMES
English: Chinese mint, horehound, hyptis, mint weed, mintweed, pignut, wild spikenard
Vernacular: kapanthe

DESCRIPTION
Annual or short-lived evergreen, upright and branched herb [1–1.5 (–3) m tall]; stems green or reddish-green, hairy, square in cross-section, woody towards the base; leaves emit a strong minty smell when crushed.

Leaves: Green, hairy, egg-shaped, oval or slightly heart-shaped (2–10 cm long and 1–7 cm wide), bases round to heart-shaped with pointed tips, margins shallowly toothed; held opposite each other on the stems, on leaf stalks 5–40 mm long.

Flowers: Pinkish, bluish-purple or lavender, tubular (5–7 mm long) with two 'lips', the upper lip has two lobes and the lower lip three; held in clusters of 1–5 flowers in the upper leaf forks.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity); splitting into two dark brown to black 'seeds' (nutlets or mericarps) (3–4 mm long and 2.5–3 mm wide).

ORIGIN
Central and tropical South America.

REASON FOR INTRODUCTION
Medicine and accidentally as a contaminant.

INVADES
Roadsides, disturbed areas, crop and fallow land, rangelands, savannahs, open woodlands, floodplains and riverbanks.

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IMPACTS

Can form dense stands, to the detriment of native fauna and flora. *H. suaveolens* now has an almost pan-tropical distribution, and is regarded as one of the world's most noxious weeds. It is believed to be allelopathic, impeding the germination of other plant species, and as such it threatens natural succession processes (Padalia *et al.*, 2014). It also physically competes for space and nutrients in grain crops and peanuts (Parsons and Cuthbertson, 2001). Near Materi, Kenya, farmers are alarmed by the rapid rate at which it is spreading and by the impacts it is having on crop and pasture production. Widely naturalized in the savannahs of northern Australia, it is there considered to pose the greatest threat to "rangeland biodiversity". It is also unpalatable to livestock and wildlife. It is also becoming increasingly invasive in India, and is naturalized in Papua New Guinea and on several Pacific islands.

Notes: Widespread and abundant in Malawi and southeast Zambia forming dense stands along roads and in fallow lands, pastureland, and elsewhere. Probably more widespread than indicated, especially in Zambia. In Zimbabwe it is found "along roadsides, in disturbed areas or as a weed of abandoned cultivation" (Flora of Zimbabwe, 2020). Regarded as a casual alien in the northern and southern regions of Zimbabwe (Maroyi, 2012).





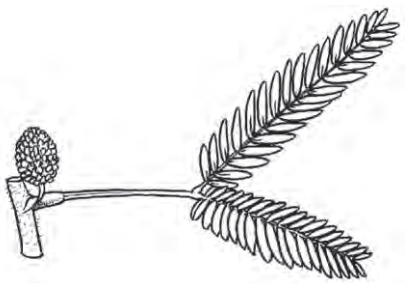


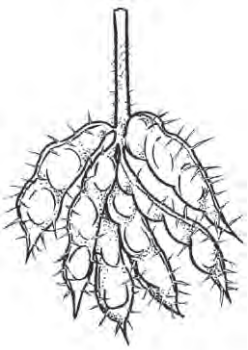


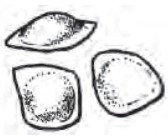
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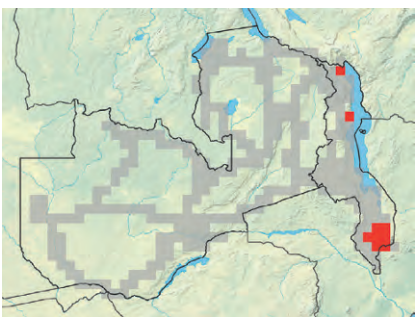
Mimosa pudica L.











PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: common sensitive plant, shame plant, sleeping grass, touch-me-not
Vernacular: swinya, tindinyari

DESCRIPTION
Evergreen prickly herbaceous plant or small shrub [15–50 (–100) cm high] with a creeping or sprawling habit; stems reddish-brown to purplish, rounded, with sparse prickles (2–2.5 mm long).

Leaves: Yellowish-green, sparsely hairy, twice-divided, 1–2 pairs of leaflet branchlets (2.5–8 cm long) each bearing 10–25 pairs of elongated leaflets with almost parallel sides (6–15 mm long and 1–3 mm wide), margins entire, borne on stalks (1.5–6 cm long), leaves fold together at night or when touched.

Flowers: Lilac or pink in fluffy round heads or clusters (9–15 mm across) held on bristly stalks (1–4 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, elongated with almost parallel sides, flattened (1–2.5 cm long and 3–6 mm wide), held in clusters covered with bristles, and with prickles along their margins, break transversely into segments; seeds light brown, flattened (2.5–3 mm long).

ORIGIN
Barbados, Belize, Bolivia, Brazil, Colombia, Costa Rica, Cuba, Dominican Republic, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Panama, Puerto Rico, Trinidad and Tobago, Surinam and Venezuela.

REASON FOR INTRODUCTION
Medicine, tannins, bee forage, ground cover and ornament.

INVADES
Roadsides, railway lines, disturbed land, wasteland, urban open spaces, gardens, fallow land, crops, plantations, managed pasture, drainage ditches, savannahs, lowlands, wetlands and gullies.

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IMPACTS

On record as posing a significant threat to native flora in some parts of the world, *M. pudica* is also a known fire hazard. It is considered to be a serious pest of crops and pastures throughout the tropics (Holm *et al.*, 1979). In Kerala, India, infestations have reduced upland rice yields by 10–70% (Joseph and Bridgit, 1993). In other infested upland rice-producing regions of the world, similar losses have been reported. It is considered to be a serious weed of sugarcane in Mexico and Taiwan (Holm *et al.*, 1977); of sorghum and maize in Malaysia and Indonesia (Holm *et al.*, 1977), and of soybeans in the Philippines (Holm *et al.*, 1977), as well as of tomatoes, pineapples and cotton (Lee Soo Ann, 1976; Waterhouse and Norris, 1987). Mimosa is also a serious weed of plantation crops such as rubber, tea, coffee, coconuts, oil palms, bananas, mangoes, papaya, citrus and even *Acacia mangium* Willd. (Fabaceae) plantations in Indonesia (Nazif, 1993). Mimosa invades pastures and can be toxic to livestock, due to the high levels of mimosine it contains. It is suspected of poisoning cattle in Papua New Guinea (Henty and Pritchard, 1973), and has caused stunted growth in chickens in Indonesia (Kostermans *et al.*, 1987).

Notes: Probably more widespread than indicated on the distribution map, and likely to be present in Zambia but difficult to detect during roadside surveys. Invasive at most localities where it was seen in Malawi. An herbarium specimen was collected in 1970 in Nkhata Bay District, Malawi. “Rare as a naturalized species” in Zimbabwe (Flora of Zimbabwe, 2020).









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Nicandra physalodes (L.) Gaertn.



TOMATO FAMILY
Solanaceae

COMMON NAMES
English: apple of Peru, Chinese lantern, Peru apple, shoofly plant, wild gooseberry, wild hops
Vernacular: doza, makhalabwinja

DESCRIPTION
Annual herb or small shrub [1–2 (–4) m tall] with spreading branches; stems hollow, angular, soft, smooth and hairless.

Leaves: Mid-green, almost hairless, egg-shaped with broad end at base (6–25 cm long and 2.5–18 cm wide), irregular, shallow or deeply lobed margins, wavy edges, held alternately on stems; leaf stalks long and slender (1–20 cm long).

Flowers: Pale blue and white, bell-shaped (2.5–4 cm across), often downward-facing, sometimes erect, short-lived.

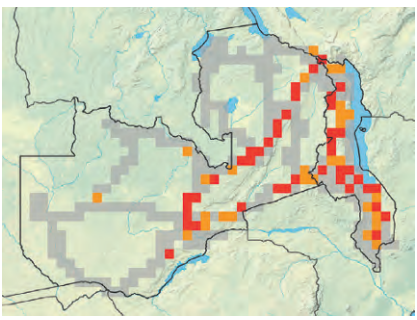


Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow as they mature, almost round (1–1.5 cm across); enclosed by a bladder-like structure, intitially green, turning brown and papery, resembling a Chinese lantern; seeds light brown, flattened (1–1.5 mm wide).

REASON FOR INTRODUCTION
Medicine and ornament.

ORIGIN
Peru.

INVADES
Roadsides, wastelands, urban open spaces, gardens, fallow land, croplands, and woodlands.



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IMPACTS

Has the ability to form dense stands, to the detriment of native plant and animal species. In Australia, it has significantly reduced the carrying capacities of some tropical pastures (Holm *et al.*, 1997). Rapid growth and canopy formation mean it can compete with other plants for light, rather than for water or nutrients (Thomas and Schwerzel, 1968). Where present in densities of 4.7 plants/ m^2, *N. physalodes* can reduce maize yields by about 35%, and impede harvesting (Hawton, 1976). The seeds are a contaminant of grass and legume seed crops in East Africa (Holm *et al.*, 1997). *N. physalodes* is also an alternative host for several crop pests.

Notes: Often found along roadsides and in disturbed areas in Malawi and Zambia. According to Flora Zambesiaca it was recorded in Malawi in Blantyre District in 1950, Dedza District in 1968, and Mzimba District in 1974. An herbarium specimen was collected in 1965 at Lake Chilwa in Zomba District with another collected in 1966 near Lilongwe at the Chitedze Agricultural Research Station. Present in Northern, Lusaka, and Southern Provinces, Zambia (Phiri, 2005). Recorded as invasive throughout Zimbabwe (Maroyi, 2012) “in disturbed ground, occurring as a weed of crops, roadsides, gardens and also in degraded woodland” (Flora of Zimbabwe, 2020).





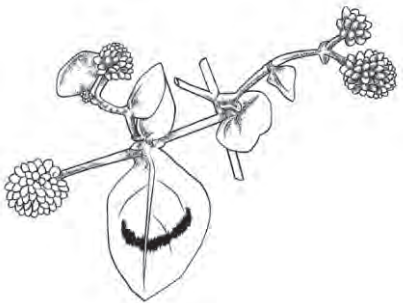




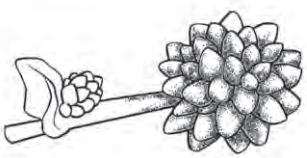


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KNOTWEED FAMILY
Polygonaceae

COMMON NAMES
English: creeping knotweed, Japanese knot weed, Japanese knotweed, knotweed, persicaria, pink-head knotweed, pinkhead knotweed, pinkhead smartweed

DESCRIPTION
Mat-forming short-lived or evergreen herb with stems [(5–) 15–25 (–35) cm long] sometimes rooting at the nodes.

Leaves: Green, paler below, oval-round to oval [1–4 (–6) cm long and 0.75–2.5 (–3.3) cm wide] with a conspicuous purple V-shaped band or blotch on both surfaces, sometimes tinged red or purple, margins with conspicuous glandular hairs, base wedge-shaped or tapering, terminal end or apex pointed; leaf stalk short (2–5 mm long).

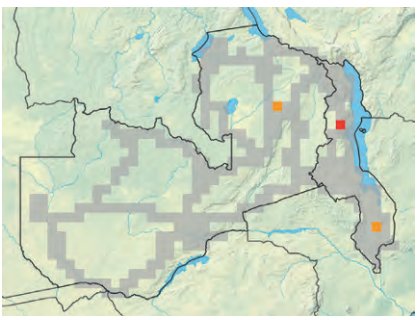
Flowers: Pinkish in roundish heads (5–20 mm long and 7–18 mm wide) at the ends of stems; individual flowers (0.5–1.25 mm wide).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity) (1–2 mm long and 0.5–0.75 mm wide), dark brown, shiny, hairless.

REASONS FOR INTRODUCTION
Medicine and ornament.

ORIGIN
Bhutan, China, India, Malaysia, Myanmar, Nepal, Thailand, and Vietnam.

INVADES
Roadsides, disturbed areas, urban open space, gardens, forest margins and plantations.



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IMPACTS

Has the ability to form a dense groundcover preventing the growth of other plant species and smothering established plants. A respondent on Dave's Garden (2019) said, "in a benign climate like ours, this plant is so invasive it will choke out almost anything, and it will not respect any form of boundary because the tiny seeds spread everywhere". Another respondent said, "though uninvited, it self-seeded from flower beds some100 yards or so away and it has now taken over three of my large flower beds and I'm aggressively removing it" (Dave's Garden, 2019). In Hawaii it is "naturalized in wet forest, open lava fields, and along roadsides" (Wagner *et al.*, 1999). Also naturalized in parts of the USA (Environmental Weeds of Australia, 2016) and found to be invasive in New Zealand and La Réunion (PIER, 2020). It is also widely naturalized in southern and eastern Australia (Environmental Weeds of Australia, 2016) and invasive in South Africa (Henderson, 2020).

Notes: Probably more widespread than indicated in the distribution map. Grown as an ornamental it has established along roadsides and urban open spaces, especially in high-lying areas. According to Flora Zambesiaca it was first recorded in Zomba, Malawi, in 1983. According to the Flora of Zimbabwe (2020) it was "introduced as a garden ornamental and is now naturalised and weedy in the high rainfall areas of the country," especially in the eastern region where it is considered to be invasive (Maroyi, 2012).









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Salvia coccinea Buc'hoz ex Etl.



MINT FAMILY
Lamiaceae

COMMON NAMES
English: blood sage, crimson sage, red sage, wild salvia

DESCRIPTION
Evergreen erect herb (to 1.5 m tall), stems covered with both short and long spreading hairs.

Leaves: Green, upper surfaces hairless to sparsely haired, densely hairy beneath; egg-shaped to triangular (1.5–6 cm long and 1–5 cm wide), tips pointed to rounded, margins toothed, held in pairs along the stems.

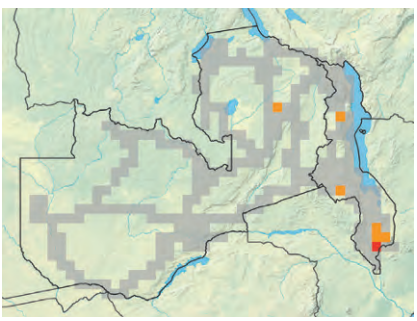
Flowers: Bright red, pink or white, tubular (15–30 mm long), held in elongated clusters at the tips of the stems, in groups of 3–10.

Fruits: Schizocarps (dry fruits that split into one-seeded segments at maturity), splitting into four one-seeded segments or 'seeds' (nutlets) when mature; brown 'seeds' smooth, narrowly egg-shaped (about 3 mm long).

ORIGIN
Mexico, Belize, Brazil, Colombia, El Salvador, Guatemala, Peru, south-eastern USA, and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, gardens, plantations, open woodlands and riparian vegetation.



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IMPACTS

Forms dense stands, displacing native plant and animal species. It is naturalized in Fiji (Smith, 1991) and in Hawaii, especially in disturbed habitats (Wagner *et al.*, 1999). In Niue, it is common in waste places and plantations (Sykes, 1970), while in Tonga it is widespread only in plantations (Yuncker, 1959). Young plants are toxic to cattle, inducing symptoms such as extreme weakness and uncoordinated movements (Hindmarsh, 1937).

Notes: Grown as an ornamental it is probably more widespread in both countries than indicated on the distribution map. It is occasionally naturalized and only regarded as invasive at one site in southern Malawi. An herbarium specimen was collected in 1950 on Zomba Mountain with another specimen subsequently collected in 1965 in Blantyre District. In Zimbabwe it is "a weed of disturbed ground, roadsides and degraded woodland" (Flora of Zimbabwe, 2020) in the northern, western, central, and eastern regions (Maroyi, 2012).

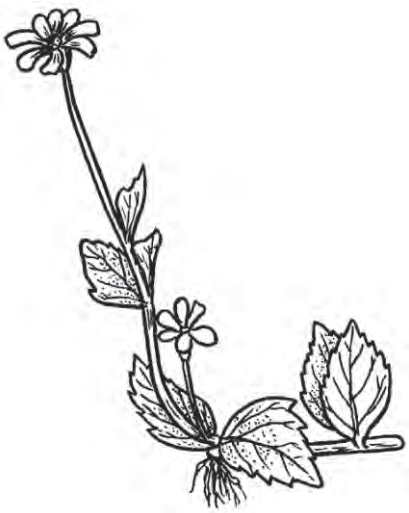


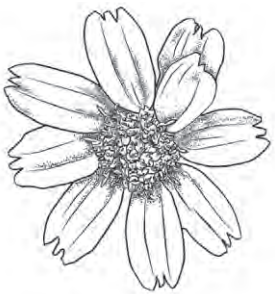




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Sphagneticola trilobata (L.) Pruski







DAISY FAMILY
Asteraceae

COMMON NAMES
English: creeping ox-eye, creeping daisy, creeping wedelia, Singapore daisy

DESCRIPTION
Evergreen creeping, mat-forming herb with a scrambling or climbing habit [15–30 (–70) cm tall]; stems green or reddish (to 2 m long), slightly hairy, rounded, rooting at the joints.

Leaves: Dark green, glossy, almost hairless, fleshy (40–180 mm long and 15–80 mm wide), three-lobed or weakly lobed to entire, sometimes toothed, held opposite each other on the stems, stalk-less or on short stalks.

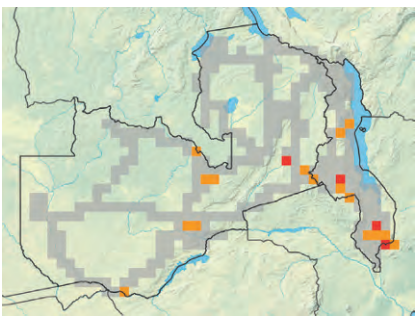
Flowers: Bright yellow to orange, daisy-like (20–35 mm across), borne singly on upright stalks (3–15 cm long).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown, elongated (4–5 mm long).

ORIGIN
Belize, Brazil, Bolivia, Colombia, Costa Rica, Ecuador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Medicine, erosion control and ornament.

INVADES
Roadsides, disturbed areas, wasteland, drainage ditches, forest edges/gaps, woodland edges/gaps and lowlands.



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IMPACTS

Forms a dense ground cover, to the detriment of other plant species. Its being allelopathic enhances its competitiveness (Zhang *et al.*, 2004). Even low-level infestations have a negative impact on plant diversity. In a study on Hainan Island, China, even a *S. trilobata* cover of 10% was found to have initiated significant declines in the diversity of native plant communities (Qi *et al.*, 2014). In South China, the invasive *S. trilobata* co-occurs with a congener *S. calendulacea* (L.) Pruski along riverbanks, coastal areas and other moist habitats but due to its rapid expansion over the last two decades, the distribution and abundance of the native *S. calendulacea* have decreased significantly (Wu *et al.*, 2013). In addition, these two species readily hybridize contributing to the further decline of the native species. In south-east Viti Levu and Taveuni Island, Fiji, *S. trilobata* has invaded fields of taro [*Colocasia esculenta* (L.) Schott; Araceae] (Macanawai, 2013). In Florida, USA, *S. trilobata* invades "agricultural areas, along roadsides and trails, along streams, waste places and disturbed sites" (UF/IFAS, 2016). Also recorded as invasive in India, Singapore, Sri Lanka and Taiwan in Asia; Sierra Leone, South Africa and Zimbabwe in Africa; Cuba, Jamaica, Puerto Rico, United States Virgin Islands in the Americas; a large number of Pacific Islands; and Australia (CABI, 2016). Also considered to be invasive in Cambodia and other countries in Southeast Asia (A.B.R. Witt, *pers. obs*.).

Notes: Probably more widespread than indicated since it is a popular ornamental. It has escaped cultivation at a number of places and is now considered to be invasive on roadsides and urban open spaces. According to the Flora of Malawi (2020) it is an "escape" on roadsides. In Zimbabwe, "it escapes from time to time, most convincingly in high rainfall areas in the Eastern Highlands but also in urban areas like Harare" (Flora of Zimbabwe, 2020).



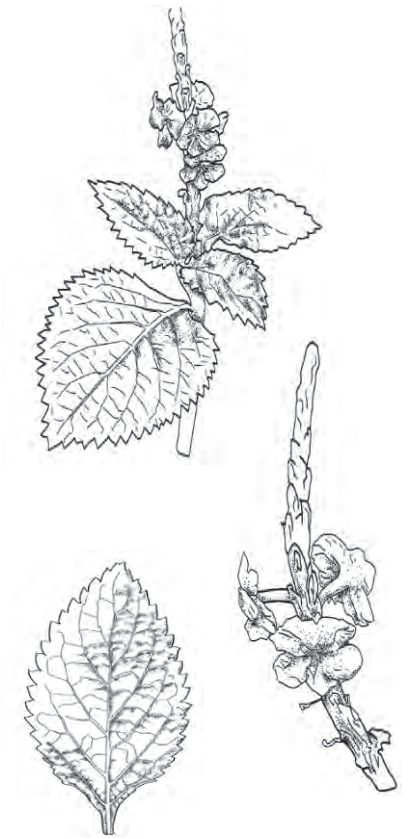


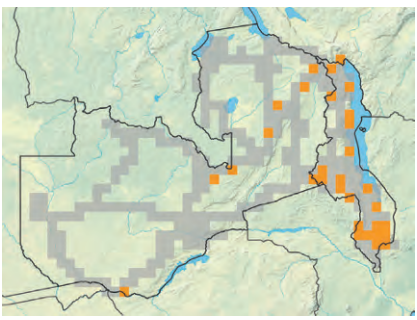


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Stachytarpheta jamaicensis (L.) Vahl







VERBENA FAMILY
Verbenaceae

COMMON NAMES
English: blue porter weed, blue snake weed, Brazilian tea, Jamaica snakeweed, porterweed, snake weed

DESCRIPTION
Evergreen shrubby herb (60–120 cm high), young stems green or purplish, mostly hairless and square in cross-section becoming rounded, light brown and woody as they mature, almost or totally hairless; woody rootstock; known to hybridize with *Stachytarpheta cayennensis* (Rich.) Vahl.

Leaves: Green with a bluish or greyish tinge, leathery, slightly fleshy, hairless or with a few hairs on veins on undersides, simple, leaves egg-shaped, oval or somewhat elongated with almost parallel sides (2–12 cm long and 1–5 cm wide) with rounded tips, margins sharp but finely toothed; leaves opposite each other on stems, on stalks 5–35 mm long; *S. cayennensis* leaves have a wrinkled appearance, margins sharp and deeply toothed.

Flowers: Light blue, blue or mauve, tubular (7–11 mm long and 8 mm across) on long, curved and thick spikes (15–50 cm long and 3–7 mm thick) at the ends of branches unlike *S. cayennensis* which has dark blue, purple or violet flowers (5 mm across) on slender spikes (1–3 mm thick).

Fruits: Schizocarp (dry fruit that splits into single-seeded parts when ripe), green turning dark brown, dark purple or black as they mature, small, somewhat elongated with almost parallel sides (3–7 mm long and 1.5–2 mm across).

ORIGIN
Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Surinam, USA, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed sites, wastelands, fallow land, plantations, managed pasture, gardens, drainage ditches, savannahs, forest edges/gaps, woodland edges/gaps, lowlands, floodplains and coastal environments.

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IMPACTS

Forms dense stands which can out-compete native plants for water and for nutrients. In Hawaii, it is naturalized in disturbed areas (Wagner *et al.*, 1999) and is common along roadsides, in wastelands and also in pastures in New Guinea (Henty and Pritchard, 1973) and Australia (Holm *et al.*, 1997). It is apparently unpalatable to livestock. In India, it is also a probable host for the cucumber mosaic cucumovirus (Mathew and Balakrishnan, 1991).

Notes: Occasionally recorded as naturalized in Malawi and Tanzania. Easy to confuse with *S. cayennensis*, which is also present elsewhere in the region (CABI, 2020). In Zimbabwe, *S. jamaicensis* is "widely cultivated as a garden ornamental, particularly in rural areas, where it locally escapes and occurs as a naturalized weed in abandoned cultivated fields, along roadsides and in disturbed places" (Flora of Zimbabwe, 2020). However, it has only been recorded "as a truly naturalised weed in the Rusitu Valley" (Flora of Zimbabwe, 2020). In Zimbabwe, *S. cayennensis* is "naturalised and weedy in grassland, along road sides and in disturbed places" (Flora of Zimbabwe, 2020).

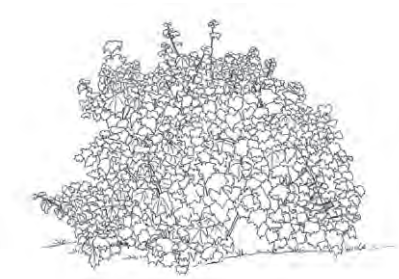




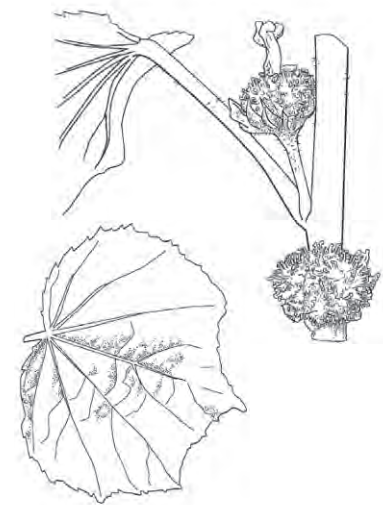


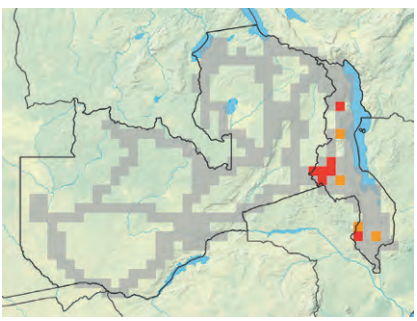
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Urena lobata L.









MALVA FAMILY
Malvaceae

COMMON NAMES
English: aramina plant; bur mallow; burr mallow; cadillo; caesarweed; caesarweed aramina; Chinese burr; Congo jute; hibiscus burr; Indian mallow; pink burr; Urena burr
Vernacular: msapatonje; kolokondwe; lumandasanga

DESCRIPTION
An upright and evergreen herbaceous plant or small shrub [0.5–2 (–3) m tall]; young stems green and covered in star-shaped hairs.

Leaves: Green, egg-shaped or somewhat circular, almost entire to shallowly 3 or 5-lobed (4–10 cm long and 1.5–8 cm wide), uppermost leaves are smaller and narrower (4–7 cm long and 1.5–3 cm wide), toothed margins and pointed tips, surfaces covered in star-shaped hairs, denser on the underside; leaf stalks are variable in length (1–9 cm long).

Flowers: Pink (1.5–2 cm across) on short stalks (2–3 mm long) in the upper leaf forks, sometimes with 2 to 3 flowers in a single fork.

Fruits: Capsules (dry fruits that open at maturity), flattened (6–10 mm across), turning from green to brown as they mature, splitting into five one-seeded segments, covered in star-shaped hairs when young and have numerous small hooked spines; seeds brown, kidney-shaped (2–3 mm across), mostly hairless.

ORIGIN
Uncertain, with some claiming the species to be native to Asia, and others Africa, but most evidence points to an Asiatic origin (Bhutan, Cambodia, China, Laos, and Taiwan), extending into Australia. Other sources also claim a South American and Caribbean origin (CABI, 2020).

REASONS FOR INTRODUCTION
Fibre and accidentally as a contaminant.

INVADES
Roadsides, disturbed areas, urban open space, riparian areas, pastures, and disturbed forests.

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IMPACTS

A fast-growing plant that has the capacity to rapidly establish dense, and occasionally monospecific stands (Langeland *et al.*, 2008). The hooked spines on the fruit easily attach to animal fur and/or people's clothing, facilitating spread (Austin, 1999). It is regarded as a noxious weed in the USA (Louisiana and Florida), Fiji, and Cuba (Randall, 2012). Naturalized in northern and eastern Australia. Also naturalized in La Réunion, Papua New Guinea, and on numerous Pacific islands such as American Samoa, the Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Guam, Niue, the Solomon Islands, Tonga and Hawaii. Widely naturalized in many countries in Africa (CABI, 2020).

Notes: Not actively recorded in Zambia although it is known to be present in Luapula, Northern, Eastern, Southern, and Western Provinces, Zambia (Phiri, 2005; Flora of Zambia, 2020), and in South Luangwa National Park (Astle *et al.*, 1997). Also recorded in dambos in North Luangwa National Park, Zambia (Smith, 1998). Under-recorded in Malawi so probably more widespread than indicated based on reports by Williamson (1954) who found it to be "present at all elevations." In Malawi it was found in large stands on roadsides and fallow croplands.





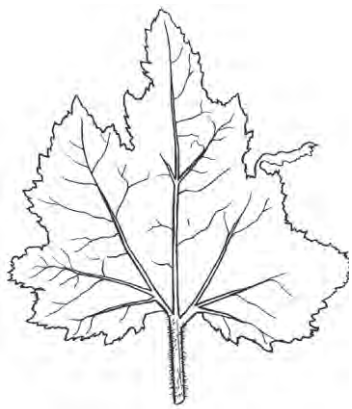


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Xanthium strumarium L.







DAISY FAMILY
Asteraceae

COMMON NAMES
English: large cocklebur, noogoora bur, sheep bur

DESCRIPTION
Annual much-branched herb with erect stems (20–150 cm high) without spines; stems stout, green, brownish or reddish-brown, roughly hairy.

Leaves: Green, paler below, hairy on both surfaces; egg-shaped to triangular or broadly three-lobed (2–8 cm long); margins irregularly toothed; held alternately on stems; long leaf stalks [2–8 (–15) cm)].

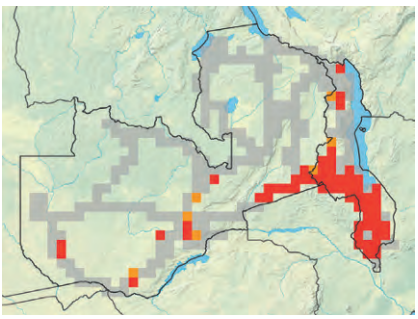
Flowers: Green, inconspicuous, in the leaf axils.

Fruits: Burs, green turning yellowish then brown as they mature, cone-shaped (1.5–2.5 cm long), covered with hooked spines (to 20 mm long), with two terminal beaks or horns.

ORIGIN
Uncertain, but probably Central and South America.

REASON FOR INTRODUCTION
Bee forage and accidentally as a contaminant.

INVADES
Roadsides, wasteland, disturbed land, fallow land, crops, plantations, drainage ditches, savannahs, water courses, lowlands, floodplains and sandy dry riverbeds.



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IMPACTS

Rapidly forms large stands, displacing other plant species. *X. strumarium* is a major weed of row crops such as soyabeans, cotton, maize and groundnuts in many parts of the world, including North America, southern Europe, the Middle East, South Africa, India and Japan (Webster and Coble, 1997). It also has a damaging impact on rice production in South-east Asia (Waterhouse, 1993). In the USA, high-density cocklebur infestations have resulted in soyabean yield losses of as much as 80% (Stoller *et al.*, 1987; Rushing and Oliver, 1998). Infestations can also decrease soyabean seed quality and harvesting efficiency (Ellis *et al.*, 1998). Even low-density cocklebur infestations in cotton fields in the USA have contributed to seed yield losses of 60–90 kg per hectare, or roughly 5% (Snipes *et al.*, 1982). Cocklebur has also caused yield losses in groundnuts of 31–39% and 88% at low and high densities, respectively, in the southern USA (Royal *et al.*, 1997). Cocklebur is also an alternative host for a number of crop pests (Hocking and Liddle, 1986). *X. strumarium* burs lodge in animal hair and in sheep's wool, reducing the quality and increasing treatment costs (Wapshere, 1974; Hocking and Liddle, 1986). The plants are toxic to livestock and can lead to death if eaten (Weaver and Lechowicz, 1983). In 2007, following a severe food shortage in Bangladesh, a large number of people died after consuming *X. strumarium* (Gurley *et al.*, 2010). It can result in allergic contact dermatitis in susceptible humans (Mitchell and Rook, 1979; Weaver and Lechowicz, 1983; Burrows and Tyrl, 1989).

Notes: Invasive in Malawi and Zambia, especially in low-lying and disturbed areas, along roadsides and croplands, where there is sufficient soil moisture. Recorded as present in Central Province, Zambia (Phiri, 2005) where it is often found in disturbed areas and along streams (Flora of Zambia, 2020). According to Wild (1968) "it is a weed of disturbed ground or moist grassland near streams throughout Rhodesia and in southern Zambia, Botswana and southern Mozambique." Reported as invasive in the northern, western, central, and southern regions of Zimbabwe (Maroyi, 2012).









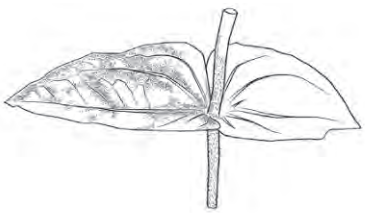
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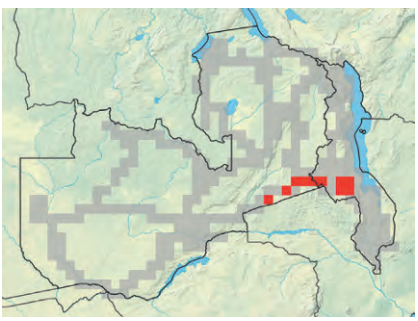
Zinnia elegans L.











DAISY FAMILY
Asteraceae

COMMON NAMES
English: youth-and-age, common zinnia, elegant zinnia

DESCRIPTION
Short-lived herb, upright [30–90 (–120) cm tall] with hairy and wrinkled stems.

Leaves: Pale green, egg- to lance-shaped (6–12 cm long and 2.5–7 cm wide), rough to the touch, held opposite each other on stem, clasping (sessile) the stem.

Flowers: Red, yellow, orange, pink, rose, lavender, green or white (4–7 cm across), held singly at end of flower stalks (8–10 cm long).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), black, oblong and flattened (8 mm long and 3–5 mm wide).

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, roadsides, and urban open space.

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IMPACTS

Forms large monocultures, excluding other species. Naturalized in different parts of the southern United States, including central Florida (Floridata, 2004). *Z. elegans* is a major host of tomato spotted wilt virus (tomato spotted wilt), turnip mosaic virus (cabbage A virus mosaic), potato yellow dwarf virus (yellow dwarf of potato), tobacco leaf curl virus, tomato foot rot (*Phytophthora cryptogea* Pethybr. & Laff.; Peronosporaceae), and the cotton aphid (*Aphis gossypii* Glover; Aphididae). These are pests and diseases of economic importance affecting a variety of agricultural crops (CABI, 2020).

Notes: Often grown around homesteads and in villages, from where it has spread and is invasive, especially along roadsides and urban open space. A single herbarium specimen of this species was collected in 1978 in Mzimba District, Malawi. No records of this species in Zimbabwe (Maroyi, 2012; Flora of Zimbabwe, 2020).







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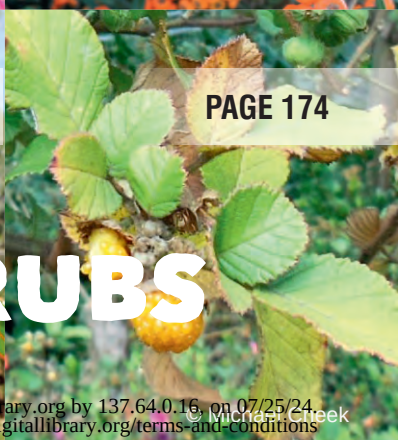

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SHRUBS

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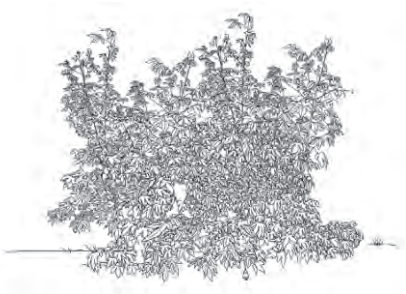

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SHRUBS

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Abutilon pictum (Gillies ex Hook.) Walp.







MALLOW FAMILY
Malvaceae

COMMON NAMES
English: abutilon, Chinese lantern, flowering maple, Indian mallow, orange lantern, painted Indian mallow, parlor maple, parlour maple, redvein Indian mallow

DESCRIPTION
Long-lived, upright shrub or small tree (5 m tall x 2 m wide) with slender, hairless branches.

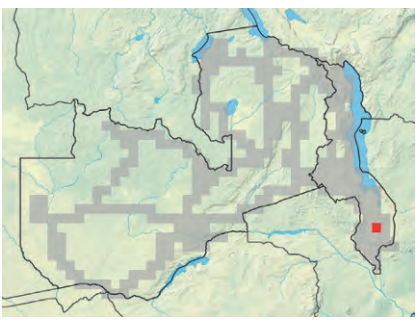
Leaves: Green (5–15 cm long and wide), 3–5 (7) lobed.

Flowers: Yellow to orange-red, bell shaped, resembling Chinese lanterns, prominent dark red veining, with five petals (brightly coloured part of flower) (2–4 cm long); flower stalk long (15 cm).

ORIGIN
Northern Argentina, southern Brazil, Ecuador, Paraguay, Peru and Uruguay.

REASON FOR INTRODUCTION
Food (flowers are edible, raw or cooked) and ornament.

INVADES
Disturbed areas, urban open space, riparian habitats, and woodland gaps/edges.



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IMPACTS

Spreads by seed and also vegetatively by layering, eventually forming very large and dense stands which displace native plants. Has escaped cultivation, and is an emerging or potential environmental weed in parts of Australia (Queensland, New South Wales and Victoria) (Environmental Weeds of Australia, 2016). According to Environmental Weeds of Australia (2016), the "dense colony-forming habit of this species, indicate that flowering maple (*Abutilon pictum*) may have the potential to become a serious environmental weed in riparian habitats in the coastal districts of eastern Australia." In the USA flowering maple can "become invasive, so gardeners should always to do their best to monitor and contain those species" (Dave's Garden, 2017).

Notes: Found to be invasive (locally abundant and spreading) in riparian vegetation in Zomba. Likely to be present elsewhere, especially in gardens, but not recorded in other localities during surveys. Not included in Flora Zambesiaca and no herbarium specimens found in Malawi.





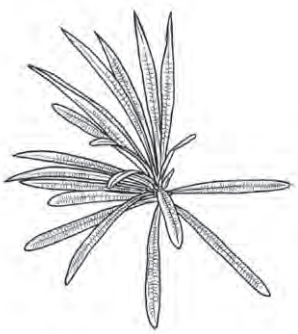


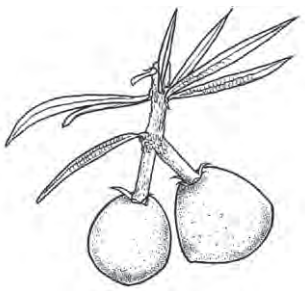


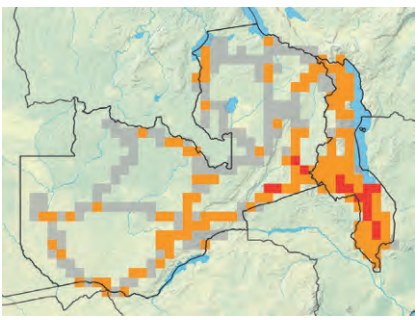
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Cascabela thevetia (L.) Lippold









SYNONYMS
Cascabela peruviana (Pers.) Raf.; *Thevetia peruviana* (Pers.) K.Schum.

OLEANDER FAMILY
Apocynaceae

COMMON NAMES
English: bestill tree, cook tree, lucky nut, luckynut, Mexican oleander, yellow oleander

DESCRIPTION
Small evergreen shrub or small tree [2–6 (–10) m high], with glossy green, hairless younger stems turning pale brown in older stems; contains milky sap in all parts.

Leaves: Bright green and glossy above, paler below, hairless, long and narrow, sword-shaped (5.5–15 cm long and 4–15 mm wide), mid-vein prominent, and conspicuous, margins downward curving, held spirally on stems, often clustered near the tips of stems, on short leaf stalks (1–4 mm long).

Flowers: Bright yellow or orange, funnel- to trumpet-shaped, spirally twisted (5–7 cm long and 5 cm wide), in clusters at the ends of branches.

Fruits: Drupes (fruits with a stony centre), green and glossy turning black and shrivelling as they mature, triangular with a raised ridge across the middle, slightly fleshy (2–3 cm wide), containing 2–4 flat seeds (35 mm long and 15 mm wide).

ORIGIN
Mexico, Peru and the Caribbean.

REASON FOR INTRODUCTION
Barrier/hedges and ornament.

INVADES
Disturbed land, urban open spaces, drainage ditches, savannah, water courses, lowlands, floodplains and gullies.

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IMPACTS

Yellow oleander forms dense thickets, especially in low-lying areas and along watercourses, displacing native plant and animal species. The plant is extremely toxic. Extracts of the leaves and bark have been found to be toxic to the fingerlings of *Channa punctata* (Bloch) (Channidae) (Singh and Singh, 2000); *Labeo rohita* Hamilton (Cyprinidae) (Singh and Singh, 2010), and *Catla catla* Hamilton (Cyprinidae) (Singh *et al.*, 2010), and to be a repellent for *Achatina fulica* (Férussac) (Achatinidae). It is often ingested intentionally by those attempting suicide, with 351 such cases reported in Sri Lanka over a three-year period, and with "thousands" of unreported cases each year, most involving deliberate ingestion by young women (Eddleston *et al.*, 1999). In one fatal incident, reported from Cyprus, a tourist from south-east Asia was seen picking and eating parts of the plant, apparently in order to commit suicide. *C. thevetia* is also allelopathic, suppressing seedling growth in wheat (*Triticum aestivum* L.; Poaceae) (Arora, 2013).

Notes: Often grown as a hedge plant in Malawi and Zambia it has escaped cultivation, especially in the former, where it has established along some waterways, including dry riverbeds, around Lake Malawi. According to herbarium records, the first specimen collected in Malawi was in 1962 at Chigumura Nursery in Blantyre District, with the second specimen collected at the foot of the Ndirande Hills in 1969. Very commonly planted in Harare gardens, Zimbabwe, but not known to be naturalized or invasive (Maroyi, 2012; Flora of Zimbabwe, 2020).

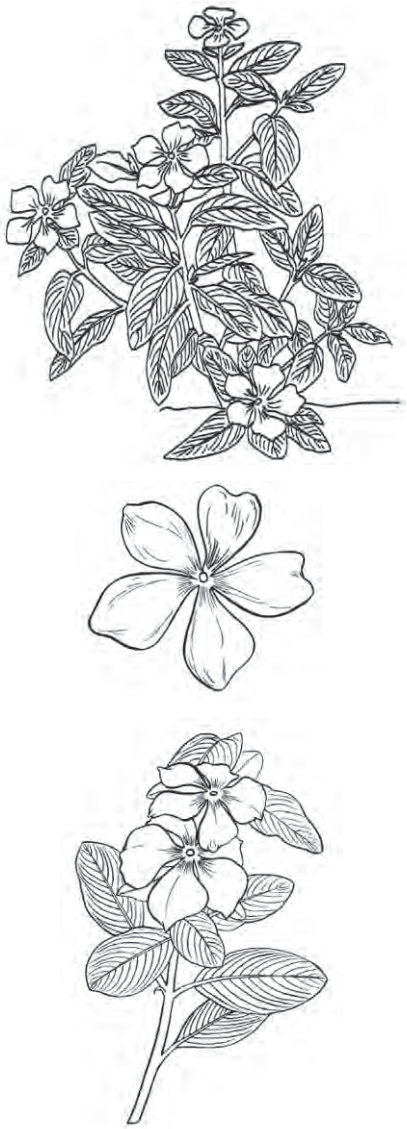






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Catharanthus roseus (L.) G. Don



SYNONYM
Vinca rosea L.

DOGBANE FAMILY
Apocynaceae

COMMON NAMES
English: Madagascar periwinkle, rosy periwinkle
Vernacular: maluati

DESCRIPTION
Evergreen erect herb or sub-shrub (30–100 cm high); woody at the base, much branched; stems green or dark red, cylindrical and longitudinally ridged or narrowly winged; contain white latex.

Leaves: Bright green, glossy, mid-vein prominent; usually hairy, sometimes hairless, egg-shaped (40–80 mm long and 10–30 mm wide), narrower at base, leaf tip is blunt with a tiny point extending from the mid-vein; short leaf stalk (2.5–9 cm long).

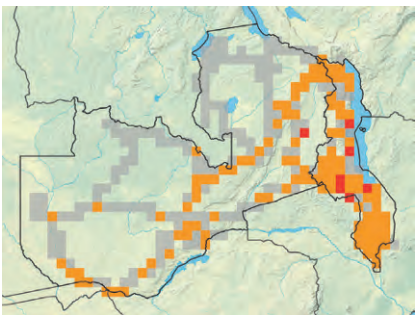
Flowers: Pink or white, solitary or paired, held in the angle between the leaf stalks and stems of the upper leaves.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity); easily mistaken for unopened flower buds; green, cylindrical (2–4.7 cm long and 3 mm wide).

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed land, wasteland, drainage ditches, woodland edges/gaps, savannah, rocky outcrops, lowlands, gullies and coastal scrub.



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IMPACTS

Rosy periwinkle can form dense stands which may be detrimental to native plant species. It does particularly well in dry savannah areas. In South Africa it invades "riverbanks, rocky outcrops, roadsides, urban areas, open spaces in dry savannah, as well as plantations, forests and coastal scrub margins" (Sztab and Henderson, 2016). It is ranked number 62 out of 200 invasive naturalized environmental weed species in south-east Queensland, and is naturalized on most of the Hawaiian Islands (PIER, 2010). In Fiji, "often found at low elevations escaped and naturalized in clearings, coconut plantations, and waste places, and along roadsides" (Smith, 1988). On other Pacific Islands it is common along roadsides, waste places and around villages (PIER, 2013). Also invasive on La Réunion Island, Mauritius and Seychelles (PIER, 2013). It is unpalatable to livestock and wildlife. On the Aldabra atoll, it dominates the low ground vegetation and is not consumed by tortoises (IUCN, undated), probably because it is toxic. Repeated oral administration of *C. roseus* leaf extracts has been found to cause diarrhoea and mortality in rats after few days of treatment (Kevin *et al.,* 2012).

Notes: Probably one of the most widely grown ornamentals in Africa, it is also common in Malawi and Zambia, where it has naturalized in many gardens, urban open spaces, and dry riverbeds. According to the Flora of Malawi (2020) it is "becoming naturalised in disturbed places, such as on roadsides, and in stream beds." The first herbarium specimen in Malawi was collected in 1966 from Samson Sonko Village on Chisi Island in Zomba District. It has been recorded in all of the nine provinces in Zambia (Phiri, 2005). In Zimbabwe, it is "commonly cultivated in gardens, and in communal lands and becoming naturalised in disturbed places, such as on roadsides, and in stream beds" (Flora of Zimbabwe, 2020). Recorded as a casual alien in the central, eastern and southern regions of Zimbabwe (Maroyi, 2012).





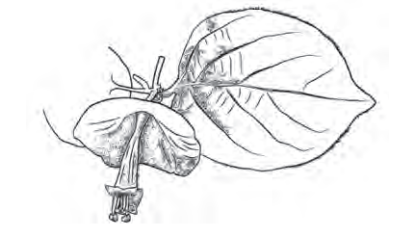


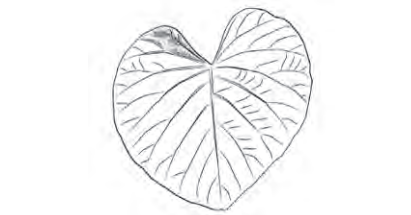
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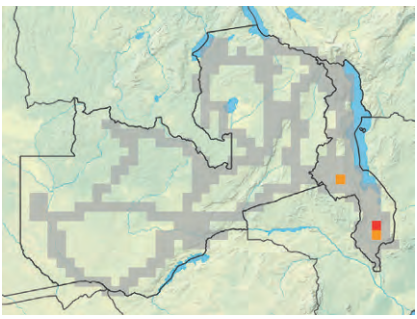
Holmskioldia sanguinea Retz.











MINT FAMILY
Lamiaceae

COMMON NAMES
English: Chinese hat plant, cup-and-saucer-plant, mandarin hat

DESCRIPTION
Creeping or erect shrub, with many basal branches, often 2 m in length; stems greyish, quadrangular (four-angled in cross-section) or cylindrical.

Leaves: Dark green above, dull below, egg-shaped or egg- to lance-shaped (3–12 cm long and 1.5–8.5 cm wide), papery, the apex or terminal end tapering gradually to a protracted point, base wedge-shaped or ending abruptly, surfaces covered with very short fine straight erect hairs, margins toothed, leaves held opposite each other on stem; leaf stalks relatively long (8–30 mm long).

Flowers: Orange to red or crimson, tubular, in clusters (5 cm long).

Fruits: Drupes (fruits with a stony centre) with four lobes (0.5–0.8 cm long), round, green turning brown as they mature.

ORIGIN
Bangladesh, Bhutan, India, Malaysia and Myanmar.

REASON FOR INTRODUCTION
Ornament.

INVADES
Urban open space, and forest edges/gaps.



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IMPACTS

Its presence in natural vegetation in Malawi did not appear to pose a significant threat to native species, although further spread and densification could result in potential biodiversity loss in the future. However, at this stage there is little data to support this contention. According to Gilman (1999), Govaerts (2014), and PIER (2014) its woodiness and persistence, tolerance of various soil conditions, and ability to reproduce by cuttings, could cause minor disruption to agriculture or unwanted growth within home gardens. It could also possibly pose a fire risk because it can accumulate dry canes (PIER, 2014). Recorded as naturalized in a number of countries worldwide including Mauritius (CABI, 2020).

Notes: Occasionally planted as an ornamental it has become naturalized in a few areas in Malawi, including urban open spaces in Lilongwe, and invasive in one locality in southern Malawi. Probably more widely grown as an ornamental in Malawi and Zambia (not actively recorded in Zambia) than indicated. This finding is supported by CABI (2020) confirming its naturalization in Malawi. Recorded as present in Zambia and Zimbabwe but no records of naturalization (Flora of Zambia, 2021; Flora of Zimbabwe, 2021).





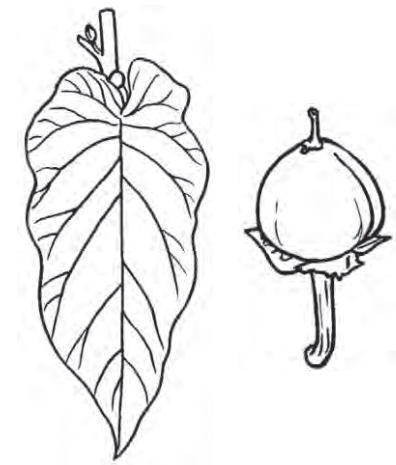


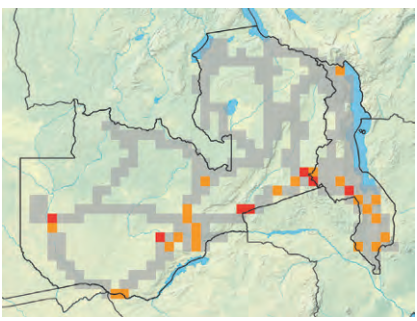


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SYNONYM
I. fistulosa Mart. Ex Choisy

MORNING GLORY FAMILY
Convolvulaceae

COMMON NAMES
English: bush morning glory, morning glory tree, pink morning glory

DESCRIPTION
Evergreen, erect to climbing or scrambling shrub (to 3 m high) with hairless woody stems, hollow at the base, soft at the tips.

Leaves: Dull green on upper surface, paler below, hairy but sometimes hairless, thick or slightly fleshy, heart- to egg-shaped (13–23 cm long and 5.5–9.5 cm across), sometimes slightly lobed with pointed tips, margins entire, held alternately on the stems, leaf stalks 5–18 cm long.

Flowers: Deep pink to rose-purple, large, trumpet-shaped (7–15 cm long and 10–15 cm wide), in several-flowered clusters, or occasionally singly, in the leaf forks, mainly at the branch tips.

Fruits: Capsules (dry fruits that open at maturity), hairless, small (2–3 cm long) with pointed tips, splitting open to release four large, hairless whitish-coloured seeds (about 10 mm long).

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Costa Rica, Guyana, Guatemala, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru and Venezuela.

REASON FOR INTRODUCTION
Barrier/hedge and ornament.

INVADES
Roadsides, disturbed areas, wastelands, drainage ditches, savannah, lowlands, gullies and riversides.

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IMPACTS

Often grown as a hedge plant, *I. carnea* has the ability to form dense stands, displacing native plant species. It is regarded as invasive in South Africa, and as naturalized in Zimbabwe. In Egypt, it has been recorded as naturalized along canals and drains, road-sides, railways, waste lands and field edges in the Nile Delta (Boulos, 1995; El-Sheikh, 1996; Al-Sodany, 1998), where it forms pure and/or mixed stands, and where invaded areas have been found to support fewer plant species (27) than uninvaded areas (50) (Sadek, 2014). It is also considered to be allelopathic (Sadek, 2014). The shrub is toxic, containing several alkaloids. In feeding trials in Argentina, five goats received fresh leaves and stems of *I. carnea*. At first, the goats did not consume the plant, but later it was preferred over any other, resulting in rapid intoxication. Clinical symptoms most commonly observed in ruminants, within one month after ingesting *I. carnea*, include lethargy, muscle tremors, dilated pupils, weakness of the hind limbs, severe incoordination, wasting and recumbence; all primarily associated with dysfunction of the central nervous system (Tokarnia *et al.*, 2002; Haraguchi *et al.*, 2003).

Notes: Grown as a living fence, or for ornament, it has often escaped cultivation, establishing in low-lying areas, especially in riparian zones and along the shores of wetlands and swamps in Malawi and Zambia. For example, it is invasive on the Kafue River floodplain in Lochinvar National Park, Zambia. In Malawi, herbarium records indicate that the first specimen was collected in 1966 at Cape Maclear, along the shores of Lake Malawi. In Zimbabwe, it is naturalized in the eastern and central regions (Maroyi, 2012), where it occurs “along riverbanks and roadside ditches, particularly near rural habitation, where it is often used as an ornamental hedge plant” (Flora of Zimbabwe, 2020).







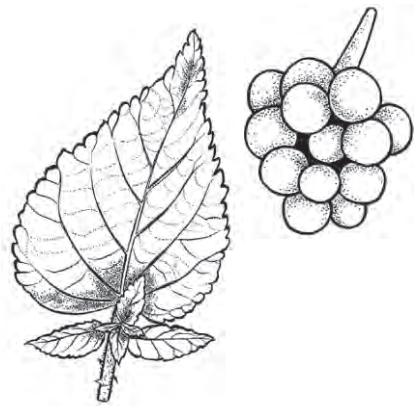


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Lantana camara L.







VERBENA FAMILY
Verbenaceae

COMMON NAMES
English: curse of India, lantana, Spanish flag, tickberry, prickly lantana, white sage
Vernacular: lantana

DESCRIPTION
Compact, scrambling long-lived shrub (to 2 m or higher), forming dense thickets; stems usually green turning grey or brown with age, square in cross-section with short hairs and hooked/recurved prickles/thorns.

Leaves: Dark green, rough, hairy, simple, egg-shaped with pointed tips (2–13 cm long and 1.5–7 cm wide), margins toothed/rough, wrinkled appearance, grow opposite one another on stems, smell strongly when crushed.

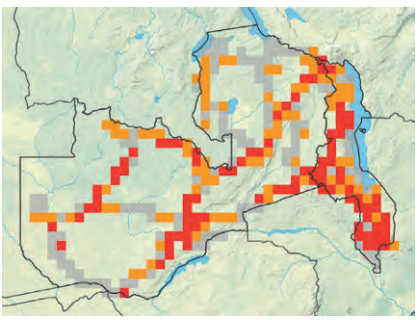
Flowers: Small red, pink, crimson, orange, yellow or white, in dense clusters (2–4 cm) across, each with about 20–40 flowers, on stalks (2–10 cm long); individual flowers are tubular (9–14 mm long and 4–10 mm across).

Fruits: Berries (fleshy fruits that do not open at maturity), initially shiny green turning purplish-black when mature (5–8 mm across), one-seeded.

REASON FOR INTRODUCTION
Hedging/barrier and ornament.

ORIGIN
Bahamas, Colombia, Costa Rica, Cuba, Hispaniola, Jamaica, Mexico and Venezuela.

INVADES
Roadsides, railways, disturbed land, wasteland, plantations, managed pasture, drainage ditches, forest edges/gaps, woodland edges/gaps, grassland, savannah, riparian vegetation, lowlands and gullies.



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IMPACTS

Lantana forms dense, impenetrable thickets, reducing biodiversity and threatening a host of rare and endangered species. In Australia, Turner and Downey (2010) identified 275 native plant species and 24 native animal species which are threatened by the presence of lantana. In crop production systems in Southeast Asia, lantana has both reduced yields and increased management costs incurred by growers of durian, pineapples, bananas and rubber (Waterhouse, 1993). Lantana is also toxic to livestock, causing pastoral losses that in Queensland, Australia, were in 1985 estimated at A$ 7.7 million, and which included 1,500 animal deaths, reduced productivity, loss of pasture, and higher control costs (van Oosterhout, 2004). In South Africa, lantana poisoning accounts for about 25% of all reported cases of livestock poisoning by plants (Wells and Stirton, 1988). There have even been recorded fatalities in people, especially children, after consuming the green fruit. Lantana can also alter fire regimes, allowing fires to penetrate into forests and woodlands.

Notes: Widespread throughout Malawi and Zambia, where it is often grown as a hedge, it has escaped cultivation at a number of sites forming dense impenetrable stands. According to Flora Zambesiaca, it was recorded in Malawi in the Dedza Mountain Forest, and Ndirande Forestry Plantation in Blantyre District in 1969, and Mzimba District in 1977. The first herbarium specimen in Malawi was collected in 1933 at Malawi Hills in Nsanje District, while others were collected in 1965 in Limbe in Blantyre District, and in 1969 in Dedza Mountain Forest. Also recorded as invasive around Mount Mulanje Forest Reserve (Shah and Makhambera, 2019). Present in Copperbelt, Northern, Central, Eastern, Lusaka, and Southern Provinces of Zambia (Phiri, 2005). Considered to be very widespread in the Victoria Falls area, “a rampant invasive plant” (Pickering and Roe, 2009) and invasive throughout Zimbabwe (Maroyi, 2012). *Lantana trifolia* is also widespread in Zambia (Phiri, 2005).





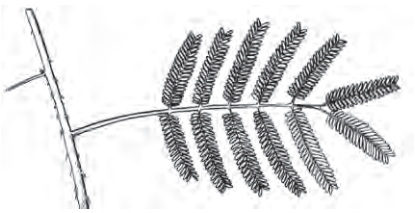


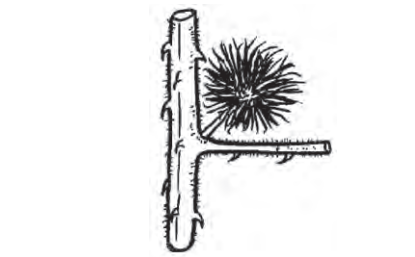


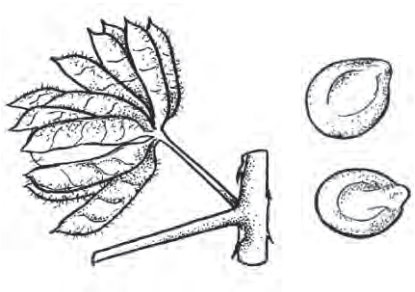
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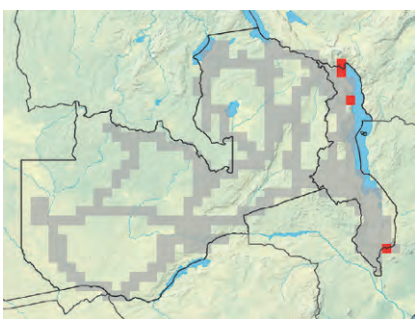
Mimosa diplotricha Sauvalle











SYNONYM
Mimosa invisa C.Mart

PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: creeping sensitive plant, nila grass, tropical blackberry
Vernacular: swinya

DESCRIPTION
Scrambling, strongly-branched climbing shrub; annual (living for more than one year but for less than two years) or evergreen; forming dense thickets [2–3 (–6) m tall], becoming woody at the base with age; stems green or purplish-tinged, 4–5-angled in cross-section, covered with sharp, recurved yellowish spines (3–6 mm long).

Leaves: Bright green, twice-divided (10–20 cm long), 4–9 pairs of leaflet branchlets each with 12–30 pairs of small elongated leaflets (6–12 mm long and 1.5 mm wide) with pointed tips; leaves fold together at night or when touched.

Flowers: Pinkish-violet or purplish, round heads (12 mm across), borne singly or in small groups on hairy stalks (3.5–16 mm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature; flat, with softly spiny edges, elongated (8–35 mm long and 3–10 mm wide); held in clusters that break into one-seeded joints; seeds light brown (1.9 mm long and 2.7 mm wide).

ORIGIN
Bolivia, Brazil, Colombia, Costa Rica, Cuba, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Jamaica, Mexico, Panama, Peru, Paraguay, Puerto Rico and Venezuela.

REASON FOR INTRODUCTION
Erosion control, nitrogen fixation, bee forage, hedge/barrier and ornament.

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INVADES

Roadsides, disturbed areas, wastelands, urban open spaces, crops, plantations, managed pasture, drainage diches, woodland edges/gaps, forest edges/gaps, woodland edges/gaps, savannahs, lowlands, wetlands and gullies.

IMPACTS

Smothers other plants, shading out light-demanding species and preventing their natural regeneration. Dense stands may prevent or inhibit the movement of livestock and wildlife. In Nigeria, *M. diplotricha* densities have reached 630,000 plants per hectare, reducing cassava-root yields, 12 months after planting, by 80% (Alabi *et al.*, 2001). The species readily invades orchards and rice paddies, reducing yields and increasing management costs (Waterhouse, 1993). Invaded cattle ranches in the Markham Valley, Papua New Guinea, are spending up to US$ 130,000 annually on chemical control (Kuniata, 1994). The majority of respondents in a survey undertaken in Malawi revealed that *M. diplotricha* was reducing the abundance of grass and shrubs in rangelands, with over half saying that it reduced crop yields (Witt *et al.*, 2020a). Invasions also reduced the availability of medicinal plants and other natural resources (Witt *et al.*, 2020a). It is apparently also toxic to livestock. In Thailand, 22 swamp buffaloes died 18–36 hours after eating *M. diplotricha* (Tungtrakanpoung and Rhienpanish, 1992). Trials in Queensland, Australia, have indicated its toxicity to sheep, and a report from Flores, Indonesia, suggests that it is also toxic to pigs (Parsons and Cuthbertson, 1992).

Notes: Invasive in northern Malawi, and to the east of Mulanje where it is forming dense thickets on roadsides, in croplands and natural pasture to the detriment of biodiversity and crop and livestock production (see Witt *et al.*, 2020a). Not seen in Zambia and not recorded in Zimbabwe (Flora of Zimbabwe, 2020).







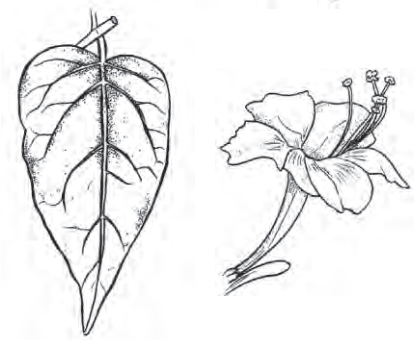


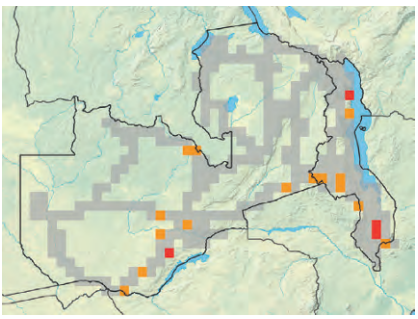
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Mirabilis jalapa L.









FOUR O'CLOCK FAMILY
Nyctaginaceae

COMMON NAMES
English: beauty of the night, false jalap, four o'clock flower, marvel of Peru
Vernacular: maluwa

DESCRIPTION
Evergreeen herb or shrub (0.5–2 m high); stems erect with multiple spreading branches; roots tuberous.

Leaves: Dark green, simple, egg-shaped (3–10 cm long), bases broad and rounded, tips pointed; held opposite each other on the stems, on leaf stalks about 4 cm long.

Flowers: White to red, yellow or striped, tubular or trumpet-like, five-lobed (6.5 cm long and 3.5 cm wide), single but sometimes held in clusters of 3–7, fragrant.

Fruits: Capsules (dry fruits that open at maturity), tiny, one-seeded.

REASON FOR INTRODUCTION
Ornament.

ORIGIN
Peru.

INVADES
Roadsides, disturbed areas, wasteland, drainage ditches, edges of irrigation channels, lowlands, riversides, swamps and gullies.

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IMPACTS

Forms dense stands which may displace native plant species, especially in areas with moister soils. Being allelopathic, *M. jalapa* inhibits the germination and growth of other plant species (Anaya and Pelayo-Benavides, 1997). Both the roots and the seeds are poisonous. Symptoms of ingestion by people may include abdominal pain, dermatitis, vomiting, nausea, diarrhoea and hallucinations (ISSA, 2016). Consumption can also cause gastroenteritis in children (Lewis and Elvin-Lewis, 2003). May also be toxic to wildlife. In Hawaii, naturalized in dry, disturbed areas (Wagner *et al.*, 1999) and in cultivated fields, including canefields, in Fiji (Smith, 1981). Considered to be invasive on many other Pacific Islands, China, New Zealand and Seychelles (PIER, 2011).

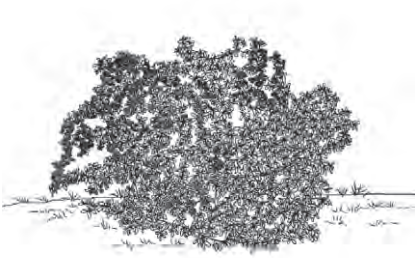
Notes: Planted as an ornamental it has occasionally naturalized in Malawi and Zambia and was recorded as invasive at a few localities, especially in low-lying areas. Also recorded as invasive in areas around Mount Mulanje Forest Reserve (Shah and Makhambera, 2019). A herbarium specimen was collected in 1960 in Dzalanyama in Dedza (Lilongwe District) with additional specimens collected in 1968 from Dedza Mountain, both in Malawi. Present in Copperbelt, Northern, and Southern Provinces of Zambia (Phiri, 2005). In Zimbabwe it is naturalized in “disturbed places, often on roadsides, sometimes in woodland and by streams” (Flora of Zimbabwe, 2020) in the western, central, eastern, and southern regions (Maroyi, 2012).



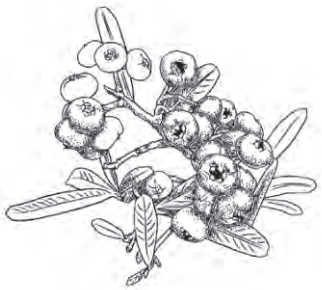




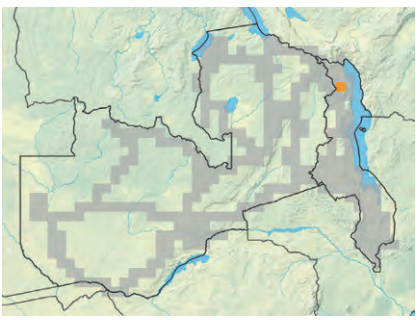
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ROSE FAMILY
Rosaceae

COMMON NAMES
English: narrowleaf firethorn, slender firethorn, yellow firethorn, woolly firethorn.

DESCRIPTION
A large upright or arching spiny shrub [2–4 (5) m tall], with stiff, spiny branches, often spreading up to 5 m across; young stems covered in thick, greyish-yellow down; older stems reddish-brown or dark grey with sharp rigid spines which bear leaves.

Leaves: Dull, dark green above, almost hairless, grey and densely hairy or downy underneath, relatively narrow (elongated) or paddle-shaped (2–7 cm long and 5–13 mm wide), margins entire, rolled under, terminal end or apex rounded, often notched or with a few pointed teeth; leaf stalks short (1–3 mm long).

Flowers: White (8–12 mm across), in dense clusters of up to 30 flowers.

Fruits: Berries (fleshy fruits that do not open at maturity), turning from green to yellow, orange or orange-red as they mature, round, but slightly flattened (5–9 mm across), with immature fruits covered in small downy hairs, each fruit contains five seeds.

ORIGIN
China.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
High altitude grasslands, rocky ridges, and riparian habitats.



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IMPACTS

A prolific seed producer with the ability to sucker from its roots means that *P. angustifolia* can rapidly form dense thickets, shading out native plants and impeding their growth and regeneration. Once established, the plant is fairly shade tolerant (Csurhes and Edwards, 1998). Dense thickets, and the presence of thorns on the plant, inhibit access to invaded areas. In southern Africa it replaces native vegetation and pasture, contaminates seed banks, and blocks access for livestock and people (Wells *et al.*, 1986). In Argentina, it inhibits the recruitment of native woody species and facilitates establishment of other invasive plant species (Giantomasi *et al.*, 2008). The seeds and leaves of many species in the genus also contain hydrogen cyanide, which if ingested may cause mild stomach ailments (Brickell, 1996). Ingestion of large quantities may result in respiratory failure and death in some animals (VRO, 2020). The spines can also injure animals (Webb *et al.*, 1988). Invasive in Hawaii and regarded as an environmental weed in Victoria, the ACT and New South Wales, and as a potential environmental weed or "sleeper weed" in other parts of southern Australia (PIER, 2011; Environmental Weeds of Australia, 2016). It is known to invade high-altitude grasslands in South Africa (Henderson, 2020).

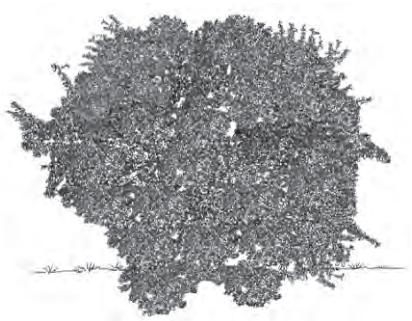
Notes: Rarely seen in Malawi and Zambia but probably more widespread in gardens than indicated. It was not actively recorded during surveys. It has escaped cultivation in Nyika National Park, and possibly elsewhere. Around Chelinda Camp, Nyika National Park, "it is known as an occasional escape into the wild" (Flora of Malawi, 2020). Herbarium specimens were collected in 1978 at Chigumula Nursery in Blantyre District, and in 1981 in Zomba District. In Zimbabwe it is "an occasional escape into the wild and is not a problem species (yet) but in the South African highveld it is known as an aggressive invader into grassland, hillsides and erosion channels" (Flora of Zimbabwe, 2020).

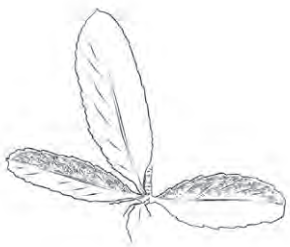






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ROSE FAMILY
Rosaceae

COMMON NAMES
English: fire thorn, firethorn, Himalayan firethorn, Nepal fire-thorn, Nepal firethorn, Nepalese firethorn, Nepalese white thorn, pyracantha

DESCRIPTION
Long-lived shrub [2–3 (–4 m] with stiff, spiny branches; young shoots/twigs rusty-downy; spines woody, sharp pointed and bearing leaves.

Leaves: Bright, glossy green above, underside dull green, narrowly oblong or lance-shaped with narrower end at base (2–6 cm long and 0.7–1.5 cm wide), hairless, margins slightly toothed, terminal end or apex pointed, bristle-tipped or rounded; leaf stalk short (3–6 mm long); in *Pyracantha angustifolia* the leaf margins are not toothed, and the underside of the leaves are densely grey-hairy.

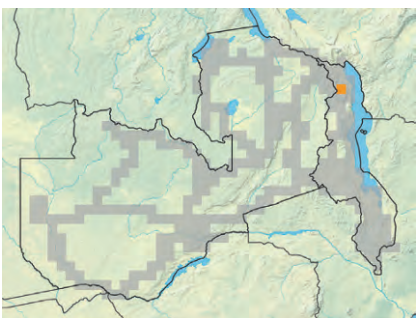
Flowers: White (6-9 mm across); flower stalks hairless.

Fruits: Berries (fleshy fruits that don't open at maturity), green turning bright orange-red as they mature (5–8 mm in diameter); stalks long and hairless (5–12 mm long).

ORIGIN
Bhutan, China, northern India, Myanmar and Nepal.

REASON FOR INTRODUCTION
Hedges and ornament.

INVADES
Grasslands, riparian areas, and rocky ridges in high altitude regions.



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IMPACTS

Has the ability to establish dense impenetrable thickets, displacing native plants and animals. In Australia *Pyracantha* species form thorny thickets in riparian areas, and associated pastures, reducing productivity and impeding the movement of grazing animals and people (Csurhes *et al.*, 2016). *Pyracantha* species are also toxic, and known to cause gastrointestinal problems in dogs (Cortinovis and Caloni, 2013). *Pyracantha* species are also hosts of *Erwinia amylovora* (Burrill) Winslow *et al.* (Enterobacteriaceae) which causes fireblight, which seriously affects apples and pear crops (Csurhes *et al.*, 2016). Regarded as an environmental weed in Victoria, New South Wales and the ACT (Environmental Weeds of Australia, 2016). In South Africa it invades high-altitude grasslands, watercourses and rocky ridges (Henderson, 2020).

Notes: Not actively recorded during surveys but found to be naturalized around Chelinda Camp in Nyika National Park. Recorded as present in Zimbabwe (Flora of Zimbabwe, 2020).









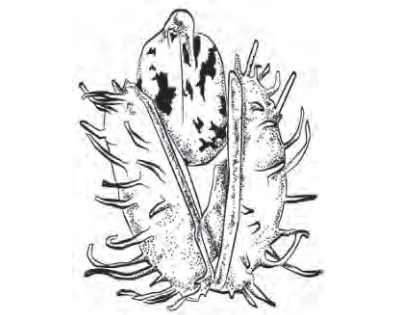


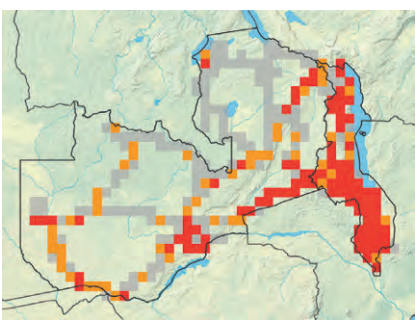
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Ricinus communis L.









EUPHORBIA FAMILY
Euphorbiaceae

COMMON NAMES
English: castor oil plant
Vernacular: impuria, mabono, mbalika, mono, msatsi, nsatsi, mayembayemba, moona

DESCRIPTION
Evergreen or annual, hairless soft-woody shrub, sometimes tree-like (1–5 m tall) with a strong taproot; shoots green or red, with a clear sap; stems hollow.

Bark: Smooth, round, often red, with conspicuous nodes and ring-like scars.

Leaves: Deep green or reddish, paler below, simple, large (10–40 cm wide), shaped like a hand with (5–) 7–9 (–12) deep lobes, margins with forward pointing sharp projections or teeth, held alternately on stems, leaf stalks round (3.5–30 cm long); leaves emit a distinctive odour when crushed.

Flowers: Small, upper flowers reddish, lower flowers creamy to greenish; male and female flowers on the same plant, both held erect in terminal clusters (to 40 cm long).

Fruits: Capsules (dry fruits that open at maturity), green turning brown or reddish as they mature, oval to almost round (15–25 mm long), three-lobed, covered in soft spines, containing up to three shiny, smooth, mottled seeds (9–17 mm long) resembling ticks.

ORIGIN
Uncertain; genetic studies of plants collected from around the world, including Ethiopia and Kenya, suggest that regional populations may "have derived from multiple sources or introductions, likely due to human-assisted migration via domestication" (Foster *et al.*, 2010). Some consider its native range to include countries in North and north-east Africa and the Middle East.

REASON FOR INTRODUCTION
Castor oil and ornament.

INVADES
Roadsides, culverts, disturbed areas, wasteland, urban open space, drainage ditches, irrigation channels, lowlands, gullies and riverbanks.

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IMPACTS

Forms dense stands which displace native vegetation, especially in riparian areas and along drainage lines (Langeland *et al.*, 2008). It readily colonizes disturbed areas, shading out native seedlings, and producing monospecific stands that replace native vegetation (Weber, 2003). In South Africa and Botswana, it has invaded savannahs and riparian and wetland habitats (Buss, 2002; Henderson, 2007), while in Australia it has invaded floodplains and coastal dunes. In Hawaii, it has invaded native dryland forests, and is altering successional processes in riparian areas (PIER, 2016). It is also invading dry forests and native shrublands in Mexico, Costa Rica, Brazil and Cuba. The plant is toxic, especially the seeds. Consumption of 2.5–6 seeds for humans and about six seeds for horses, can be fatal (Wedin *et al.*, 1986) with symptoms in people including "stomach irritation, diarrhoea, abdominal pain, increased heart rate, profuse sweating, convulsions and collapse, while even the broken seeds can cause skin irritations" (Cal-IPC, undated; Francis, undated in ISSG, 2015).

Notes: Widespread and invasive at many localities throughout Malawi and Zambia, especially along roadsides, dry river beds, and fallow lands. More than 60 years ago it was already found to be "very widespread, often found in the gardens of old women" in Malawi (Williamson, 1954). An herbarium specimen was collected in 1963 at Kambona Village in Mangochi District. According to Flora Zambesiaca it has also been recorded in Mzuzu, Mzimba District, in 1975; Dedza Mountain in 1967; and Mwanza District in 1975. It is present in all of the nine provinces in Zambia (Phiri, 2005), including South Luangwa National Park (Astle *et al.*, 1997), and is invasive in all regions of Zimbabwe (Maroyi, 2012; Flora of Zimbabwe, 2020).









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Rubus ellipticus Sm.







FAMILY
Rosaceae

COMMON NAMES
English: golden Himalayan raspberry, yellow Himalayan raspberry
Vernacular: kakande, mpandankhuku, nkandankhuku

DESCRIPTION
Large stout, weakly climbing, evergreen shrub with arching branches that can grow to up to 4.5 m in height with scattered, recurved thorns, and numerous bristles.

Leaves: Dark green, with 3 thick leaflets, terminal largest (6–8 cm long and 5–6.5 cm wide), notched at tip, heart-shaped—attached to leaf stalk at pointed end, upper surface with some stiffened hairs, lower surface velvety, midrib with a few small, stout, recurved prickles and smaller straight ones, margins toothed; leaf stalks (1.5–3 cm long) covered with long, straight prickles and scattered stout, recurved prickles.

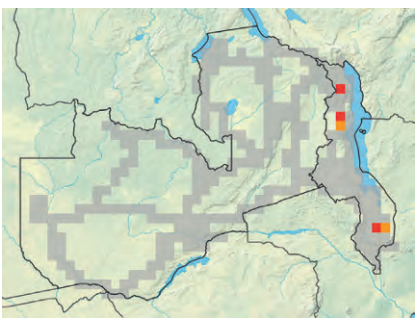
Flowers: White or yellow, in short, terminal clusters, covered throughout with short prickles, flower stalks variable (3–10 mm long).

Fruit: Multiple drupes or drupelets (fruits with a stony centre), 'fused' or clustered together, berry-like, golden yellow, depressed-hemispherical (ca. 0.8 cm long), hairless.

ORIGIN
Asia.

REASON FOR INTRODUCTION
Food, medicine, dye making, and ornament.

INVADES
Disturbed areas, roadsides, riverbanks, agricultural areas, natural forest edges/gaps and grasslands.



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IMPACTS

With its aggressive growth, it out-competes other species, forming dense monospecific stands which threaten native flora and alter ecosystems. In Hawaii, it is displacing native flora including the native Hawaiian species *Rubus hawaiiensis* A. Gray (Benton, 2005; ISSG, 2015)**.** It also affects wildlife by impeding movement and reducing the quality of habitats (PIER, 2012; CABI, 2019). Evidence of allelopathy has also been observed. Himalayan raspberry can support large populations of fruit flies that breed on the rotting fruit (ISSG, 2015) posing a threat to the commercial fruit industry. Invasion in grasslands reduces important pasture grasses which negatively impact on livestock production.

Notes: Probably more widespread than indicated, especially in Malawi, with no records for Zambia. Relatively common in many of the higher-lying areas in Malawi, especially Nyika National Park and Mulanje Mountain Forest Reserve. More than 60 years ago *R. ellipticus* was already naturalized on Mulanje Mountain while an unnamed European *Rubus* species was running wild at Livingstonia, regarded as a pest in gardens (Williamson, 1954). According to Flora Zambesiaca, *R. ellipticus* was seen along the Kaziwiziwi River in Rumphi District in 1959 and on the Zomba Plateau in 1960. Herbarium specimens were collected on Zomba Mountan in 1966 and 1967. Also recorded in Flora of Malawi (2020) as “locally common.”









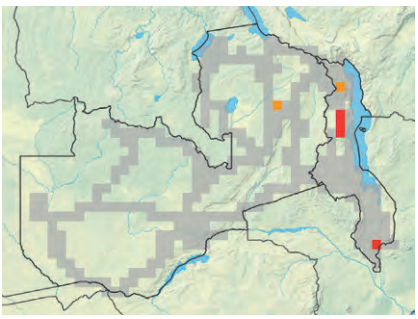
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Rubus niveus Thunb.









ROSE FAMILY
Rosaceae

COMMON NAMES
English: Ceylon raspberry, hill raspberry, mysore raspberry
Vernacular: kakande, nazambara

DESCRIPTION
Prickly scrambling shrub or climber (1.5–3 m high); the reddish mature stems have a whitish 'coat' or covering, armed with sharp, hooked thorns (4–7 mm long).

Leaves: Green above and whitish below, with 5–7 toothed, egg-shaped leaflets, (terminal leaflet 5–17 cm long and 4–8 cm wide); leaf stalks 15–50 mm long.

Flowers: Pink or mauve (10–15 mm across) with five petals (brightly coloured parts of flower), in dense clusters (2–5 cm long).

Fruits: Multiple drupes or drupelets (fruits with a stony centre) 'fused' or clustered together, berry-like, white, pink or deep purplish (10–15 mm across).

ORIGIN
Afghanistan, China, India, Malaysia, Philippines, Sri Lanka and Taiwan.

REASON FOR INTRODUCTION
Edible fruits, barrier/hedge and ornament.

INVADES
Roadsides, disturbed areas, urban open space, plantations, forest edges/gaps, woodlands, woodland edges/gaps and riparian vegetation.

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IMPACTS

R. niveus has the ability to form dense, thorny thickets up to 4.5 m tall, which out-compete and displace native vegetation, inhibiting the regeneration of native species and threatening rare endemic plants (Rentería *et al.*, 2012). It is a transformer species in that it alters the structure and condition of ecosystems over large areas. Its invasion success can be attributed to its rapid growth and ability to produce very large numbers of seeds (Rentería *et al.*, 2012). It spread extremely rapidly after being introduced to the Galápagos, covering an estimated 30,000 ha by 2008, while having the potential to spread over 90,000 ha (Atkinson *et al.*, 2008). In the *Scalesia* (daisy tree) forests of Los Gemelos, Santa Cruz, thickets of *R. niveus*, by blocking access to available light, are preventing the regeneration of shade-intolerant understorey plants such as *Scalesia pedunculata* Hook.f. (Asteraceae), an endemic species (Rentería and Buddenhagen, 2006). *R. niveus* infestations have led to declines in both the species richness and abundance of native plants (Rentería, 2011), with serious consequences for wildlife dependent on them (Weber, 2003). *R. niveus* has also invaded agricultural land, causing serious economic problems for farmers.

Notes: Not as common or widespread as *R. ellipticus* but invasive in some areas in Malawi, especially Nyika National Park. According to Flora Zambesiaca it was seen at Chelinda Camp, on the Nyika Plateau, in 1970. A herbarium specimen, dated 1975, was collected at Bvumbwe Research Station in Thyolo District. Also present in the Northern Province, Zambia (Phiri, 2005) and previously recorded in both countries by Drummond (1975). In Zimbabwe it is invasive in the northern, central and eastern regions (Maroyi, 2012) especially in “grassland, woodland and bracken scrub, mostly in disturbed areas” (Flora of Zimbabwe, 2020).







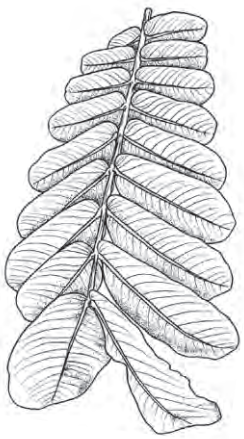


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Senna alata (L.) Roxb.







PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: candle bush, Christmas candle, ringworm senna, stick senna
Vernacular: kalisapwe (*Senna* spp.), maluwa, mtanthanyerere

DESCRIPTION
Large, spreading shrub [2–3 (–4) m tall], often with thick foliage on a few rather coarse branches.

Leaves: Green, finely hairy, once-divided (45–80 cm long and 12–25 cm wide) with 8–14 pairs of large elongated leaflets with almost parallel sides, leaflets oval or egg-shaped (5–17 cm long and 2–5.5 cm wide), margins entire, tips rounded or slightly notched.

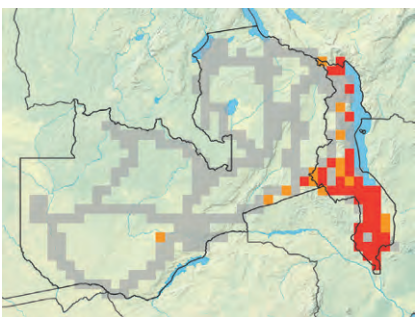
Flowers: Golden-yellow or orange (2–3 cm across) in very showy, elongated clusters (15–60 cm long) at the tips of the stems or in the upper leaf forks, on hairy stalks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown-black as they mature, large, elongated (12–25 cm long and 8–20 mm wide), 4-angled in cross section, containing about 50 seeds.

ORIGIN
Brazil, Colombia, French Guiana, Guyana, Surinam and Venezuela.

REASON FOR INTRODUCTION
Erosion control and ornament.

INVADES
Disturbed areas, urban open space, wastelands, waterways, floodplains and drainage lines.



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IMPACTS

Has the ability to establish dense stands, especially in areas with a high-water tables, to the detriment of native plants and animals (Csurhes and Edwards, 1998). Its large leaves shade out native plants, contributing to a reduced plant species richness under canopies. *S. alata* is also damaging to agriculture and to pasture production (Weber, 2003). In Hawaii, it has formed dense stands in pastures (Motooka *et al.*, 2003). In Papua New Guinea, it is also proving troublesome on some pasture lands (Henty and Pritchard, 1973). In Fiji, it has become naturalized in some swampy areas (Smith, 1985), while in Australia it is common in moist zones, as well as in some disturbed and overgrazed areas (Smith, 2002).

Notes: Often grown as an ornamental throughout much of Malawi, but less so in Zambia. It has escaped cultivation at a number of localities in Malawi, forming small stands, especially around human habitation. Herbarium specimens in Malawi were collected in 1980 at Mpinganjira Village in Mangochi District, followed by collections in Mwenekuwa Village in Machinga District. Probably more widespread in Zambia than indicated.

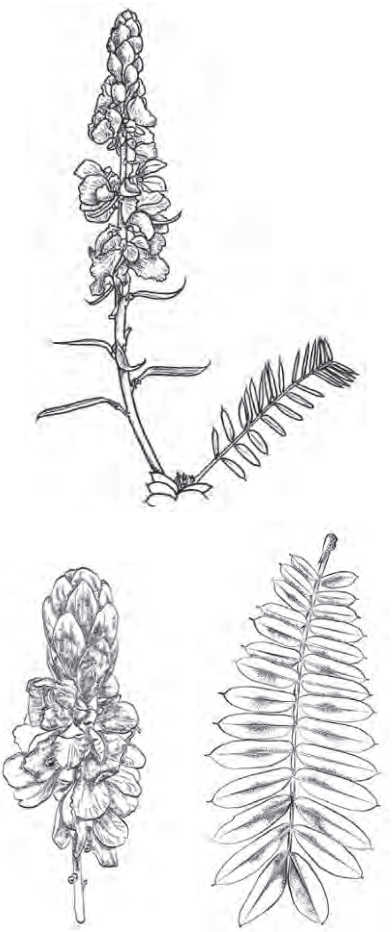








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FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: candle bush, peanut-butter cassia, popcorn senna, wild senna

DESCRIPTION
Evergreen aromatic large shrub or small tree (1–9 m tall); stems spreading, much-branched, covered with fine hairs; flowers and cut stems smell of peanut butter, although some maintain they smell of mice.

Leaves: Dark green, once divided, main leaf stems to 40 cm long, 8–18 pairs of elongated and narrow to oval leaflets [2–5 (–6.5) cm long] with asymmetric (unequal) bases and short, pointed tips.

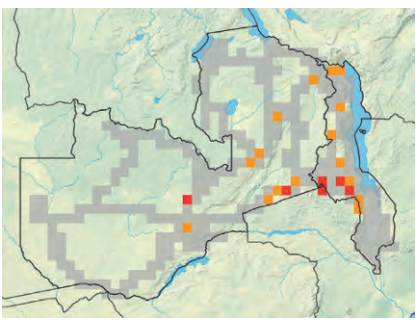
Flowers: Bright yellow, 20–30, held on erect spike-like, unbranched inflorescences or clusters (10–50 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, flat (10 cm long and 2 cm wide) with a long beak at the terminal end; containing up to 16 bean-like seeds (to 1 cm long).

ORIGIN
Angola, Ethiopia, Kenya, Sudan, Uganda and the Democratic Republic of the Congo, south to Namibia, Zimbabwe and Mozambique although its origin in the last three countries is uncertain/disputed. According to the Flora of Zimbabwe (2020), it is "probably introduced" and its status in Malawi uncertain (Flora of Malawi, 2020).

REASON FOR INTRODUCTION
Possibly native; introduced for medicine and ornament.

INVADES
Roadsides, wastelands, disturbed areas, urban open space, grasslands, savannahs, woodlands and riparian vegetation.



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IMPACTS

Has the ability to form large, dense monospecific stands, displacing native plant species and inhibiting wildlife movement (Weber, 2003). In Hawaii, it is naturalized (Wagner *et al.*, 1999). Its leaves are toxic, and have been the reported cause of numerous livestock deaths. In southern California, it is invasive in wetlands, riparian habitats, oak woodlands, chaparral, grasslands and coastal sage habitats adjacent to cultivated areas. Also considered to be invasive in South Africa (Henderson, 2020).

Notes: Invasive in some localities in Malawi and Zambia, often in disturbed areas, especially along roadsides. Probably more widespread than indicated. In Zimbabwe it is a weed of disturbed areas, often in communal lands (Flora of Zimbabwe, 2020).







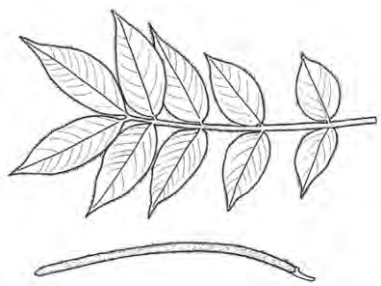


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Senna hirsuta (L.) H.S. Irwin & Barneby







PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: stinking cassia, hairy senna, sicklepod, shower tree senna
Vernacular: kalisapwe (*Senna* spp.), mtanthanyerere

DESCRIPTION
Erect herbaceous plant/shrub, becoming slightly woody with age (0.5–3 m tall); stems, leaves and pods covered with long, pale greyish-white hairs; stems ridged lengthwise.

Leaves: Greyish-green, once-divided (10–25 cm long) with (2–) 3–5 (–6) pairs of large egg-shaped or oval leaflets (50–75 mm long), margins entire with pointed tips; ribbed stalks (40–65 mm long) with a stalk-less, finger-like gland.

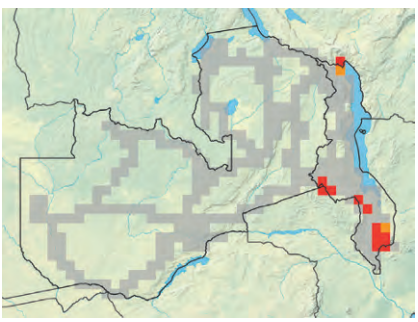
Flowers: Yellow to deep orange-yellow becoming brown-veined with age, in small unbranched clusters of 2–8 in the upper leaf forks or at the tips of the branches.

Fruit: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, slender, slightly sickle-shaped (10–18 cm long and 4–6 mm wide), densely covered with long whitish hairs; seeds dark brown, round.

ORIGIN
Central America, tropical and subtropical America and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Disturbed areas, wastelands, roadsides, riparian zones (banks of watercourses), forest margins and gaps, open woodlands and pastures.



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IMPACTS

Has established large monospecific stands, especially on roadsides, displacing native species. In Fiji, it is established in villages and plantations, along roadsides, and on riverbanks (Smith, 1985). In South Africa, it is often grown as a garden plant and has become a competitive weed in summer rainfall areas (Wells *et al.*, 1986). The leaves are reported to be toxic to rats and as such the plant is probably not palatable to livestock (Hacker, 1990). Also reported as being invasive on a number of other Pacific Islands, Singapore and Australia (PIER, 2010) and regarded as a weed in India (Holm *et al.*, 1979). A congener, *S. tora* (L.) Roxb., which is also invasive in a number of countries, and considered to have similar attributes as *S. hirsuta*, is known to be allelopathic, inhibiting seed germination and the growth of *Brassica campestris* L. in field trials undertaken in India (Sarkar *et al.*, 2012).

Notes: Relatively widespread in Malawi but not recorded in Zambia where it may have been overlooked. Found to be invasive, forming small dense stands at most sites where it was seen, especially along roadsides and woodland edges. An herbarium specimen was collected in 1969 at Nchenachena in Rumphi District. Also reported by Drummond (1975) to be present in Malawi and recorded as a casual alien in the eastern region of Zimbabwe (Maroyi, 2012).







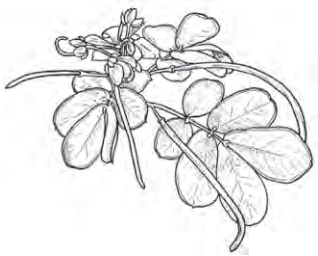


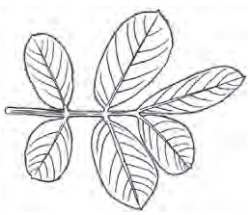
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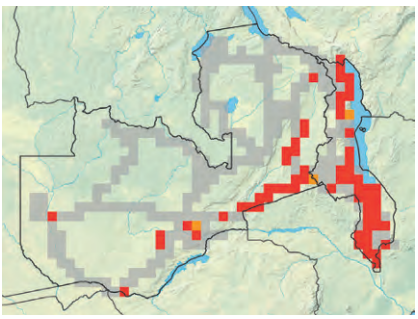
Senna obtusifolia (L.) H.S. Irwin & Barneby











PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: coffee weed, Java bean, sickle senna, sicklepod
Vernacular: kalisapwe (*Senna* spp.), mpala ntanga, mtanthanyerere

DESCRIPTION
Annual or biennial (plant that lives for longer than one year but less than two) shrub (to 2 m tall), lower stems sprawling (1.5–2 m long), young stems hairy becoming hairless.

Leaves: Green, once divided, arranged alternately on stems, with 2 or 3 pairs of hairless or sparsely hairy, egg-shaped leaflets (17–65 mm long and 10–40 mm wide) with rounded tips.

Flowers: Yellow (10–15 mm across), on stalks (7–28 mm long), usually in pairs in the leaf forks near the tips of branches.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brownish-green as they mature, slender, sickle-shaped (6–18 cm long and 2–6 mm wide), almost round in cross section; seeds (3–6 mm long) dark brown, shiny.

ORIGIN
Southern and eastern USA, Mexico, Central America, the Caribbean and tropical South America.

REASON FOR INTRODUCTION
Medicine and accidentally as a contaminant.

INVADES
Disturbed sites, waste areas, roadsides and riparian zones.

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IMPACTS

Forms dense stands that can displace native plant and animal species. In parts of Australia and in the Galapagos archipelago, *S. obtusifolia* is spreading into protected areas (Hoffmann *et al.*, 1999; Tye *et al.*, 2003), where it may out-compete and displace some vulnerable native species (Mackey *et al.*, 1997), causing irreversible ecological change (Tye *et al.*, 2003). Infestations in northern Australia are believed to have increased the risk of rainforest degradation by wild fires during the dry season (Russell-Smith and Bowman, 1992). Invasions in Australia's Iron Range National Park may also result in fewer visits by tourists (Mackey *et al.*, 1997). In Georgia, USA, *S. obtusifolia* is regarded as the most troublesome crop-weed across the State (Webster and Macdonald, 2001). Failure to control *S. obtusifolia* and *Senna tora* (L.) Roxb. (Fabaceae) within 2–4 weeks after planting has been found to reduce crop yields dramatically (Holm *et al.*, 1997), by 25% in the case of cotton (Buchanan and Burns, 1971). Soyabean yields, too, may be significantly reduced (Thurlow and Buchanan, 1972). Invasions in Queensland, Australia, have reduced the cattle carrying capacities of some pastures by almost 100% (Mackey *et al.*, 1997). *S. obtusifolia* is an alternative host for many crop pests (Davies, 1972; Patel and Patel, 1972; Debrot, 1974; Subba Rao *et al.*, 1974; McLean and Roy, 1991). In Benin, *S. obtusifolia* has gained notoriety among farmers as an alternative host for cowpea pests (Kossou *et al.*, 2001). The plant is unpalatable, but cattle may occasionally eat it when other forage is scarce, and poisoning may result (Mackey *et al.*, 1997). The seeds are known to be harmful to chickens (Cock and Evans, 1984).

Notes: Widespread and abundant in both Malawi and Zambia, but probably under-recorded in much of the latter. Often forming very large and dense stands in overgrazed/disturbed grasslands, and in the understorey of woodlands. An herbarium specimen was collected in 1972 in Karonga District. Recorded as present in seven of the nine provinces in Zambia (Phiri, 2005), including South (Astle *et al.*, 1997) and North Luangwa National Parks (Smith, 1998). Previously also recorded in both Malawi and Zambia by Drummond (1975). In Zimbabwe, it is naturalized in all regions (Maroyi, 2012) occurring in "grassland, woodland and riverine areas, usually in disturbed or overgrazed soils" (Flora of Zimbabwe, 2020).









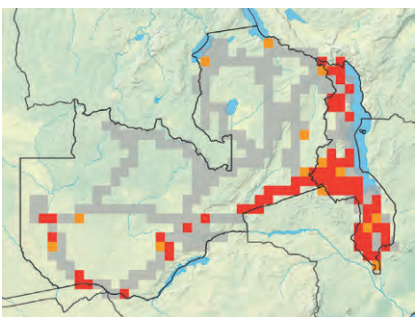
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Senna occidentalis (L.) Link









PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: ant bush, arsenic bush, coffee senna, sicklepod, stinkweed
Vernacular: kalisapwe (*Senna* spp.), khesha, maluwa, mtanthanyerere

DESCRIPTION
Erect herb or shrub (0.5–2.5 m tall); annual or living for more than one year but for less than two years; stems reddish-purple, smooth, hairless or sparsely hairy, four-angled or grooved when young becoming greenish-brown and rounded; emits an unpleasant smell.

Leaves: Green, once-divided (15–20 cm long), with (3–) 4–5 (–6) pairs of egg- to sword-shaped leaflets (3–10 cm long and 2–3 cm wide) with broad and rounded bases, tapering towards the end, with pointed tips; conspicuous gland at the base of each leaf stalk; held alternately on stems, on reddish stalks (3–5 cm long).

Flowers: Pale yellow (20–30 mm across) in small clusters of 2–6, in the forks of the uppermost leaves.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature with thickened margins, slightly curled (75–130 mm long and 8–10 mm wide), held upright.

ORIGIN
Argentina, Belize, Bolivia, Brazil, Cayman Islands, Costa Rica, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Nicaragua, Panama, Peru, Surinam and Venezuela.

REASON FOR INTRODUCTION
Coffee substitute, medicine and ornament.

INVADES
Roadsides, wasteland, disturbed land, fallow land, managed pastures, drainage ditches, woodland edges/gaps, savannahs, riparian vegetation and gullies.

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IMPACTS

Dense stands can displace native plant species, and can reduce livestock carrying capacities in managed and natural pastures. In crop production systems, *S. occidentalis* competes aggressively for nutrients, water and light. Being allelopathic, it inhibits the germination and growth of other plants. Studies have shown that it has a negative impact on maize yields (Arora, 2013), and that it significantly reduces seed cotton yields, reducing cotton main stem height by 1.25 cm (Higgins *et al.*, 1986). It is also an alternative host for crop diseases such as potato virus Y (Suteri *et al.*, 1979). The seeds are highly toxic, containing compounds that damage the liver, the vascular system and the heart and lungs of domestic livestock, often leading to death in cattle (Schmitz and Denton, 1977; Rogers *et al.*, 1979; Barros *et al.*, 1999), in horses (Martin *et al.*, 1981; Irigoyen *et al.*, 1991; Riet-Correa *et al.*, 1998), in goats (Suliman *et al.*, 1982; Suliman and Shommein, 1986), in pigs (Colvin *et al.*, 1986; Martins *et al.*, 1986), in poultry (Torres *et al.*, 1971; Haraguchi *et al.*, 1998), and in rabbits (O'Hara and Pierce, 1974). Consumption of the seeds in western Uttar Pradesh, India, resulted in the deaths of nine children within five days (Vashishtha *et al.*, 2007).

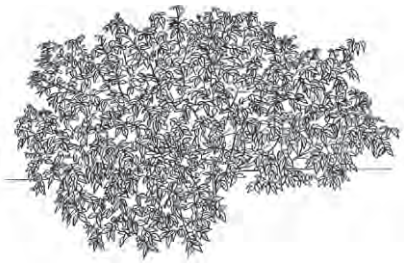
Notes: Probably more widespread than *S. obtusifolia* in both Malawi and Zambia but does not form very large stands. Often found on roadsides, around human habitation and disturbed sites. Present in Malawi for many years with an herbarium specimen collected in 1937 in Zomba District. Present in eight of the nine provinces in Zambia (Phiri, 2005), including South (Astle *et al.*, 1997) and North Luangwa National Parks (Smith, 1998). Widespread throughout southern Africa (Drummond, 1975), including Zimbabwe where it is considered to be invasive in all regions (Maroyi, 2012).



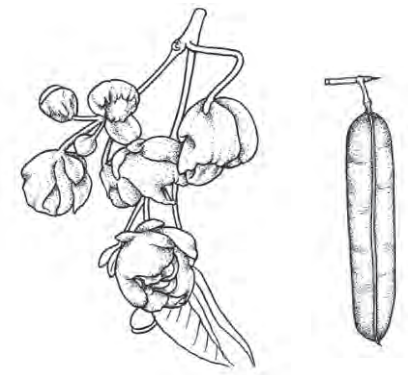




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PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: arsenic bush, Brazilian buttercup, smooth senna, yellow shower
Vernacular: kalisapwe (*Senna* spp.), mtanthanyerere

DESCRIPTION
Evergreen medium-sized leafy shrub or small tree [1–3 (–5) m tall], stem erect with spreading branches; stem surface rough with no hairs.

Leaves: Bright green above and paler beneath, once-divided (6–10.5 cm long) with 3–5 pairs of smooth, elongated to egg-shaped leaflets (3.5–9 cm long and 15–35 mm wide), margins entire with pointed tips; cone-shaped structure (gland) between the lowest three or four pairs of leaflets.

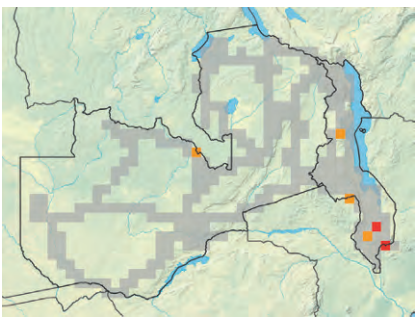
Flowers: Bright yellow, sometimes brown-veined, in clusters (2.5–8 cm long) of 4–10 flowers.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, cylindrical, inflated, ends rounded (5–10 cm long and 7–12 mm wide), containing about 6 green-brown seeds.

ORIGIN
Costa Rica, Guatemala, Honduras, Mexico and Nicaragua.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, plantations, forest gaps/edges and riparian vegetation.



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IMPACTS

Forms dense stands which can displace native plant species, and prevent their regeneration. In South Africa it is a "common garden ornamental plant that also invades forest margins, savannah, riverbanks, roadsides, waste ground and plantations" (ISSA, 2016). Other impacts are likely to be similar to those reported for other *Senna* species.

Notes: Not nearly as abundant or widespread as other invasive *Senna* species, and rare in Zambia but possibly under-reported. An herbarium specimen was collected in 1963 along the Mulnguzi River in Malawi. In Zimbabwe it considered to be naturalized in the western, central, eastern, and southern regions (Maroyi, 2012) in "woodland, disturbed grassland and at the edges of sub-montane and riverine forests; sometimes in stream beds" (Flora of Zimbabwe, 2020).









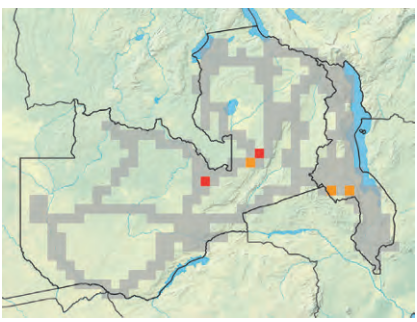
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Solanum chrysotrichum Schltdl.









TOMATO FAMILY
Solanaceae

COMMON NAMES
English: devil's fig, giant devil's fig
Vernacular: chipiwindanda*, impwa*, mapilinganga* (**Solanum* spp.), nthula

DESCRIPTION
An upright shrub or small tree (1.5–4 m tall) with prickly stems and leaves; younger stems covered in green prickles (2–6 mm long); older stems greyish and covered in large thorns (3–9 mm long and 5 mm wide at base); differentiated from other *Solanum* species by the coarse, reddish-brown hairs on stems, and under-surfaces of leaves; *S. torvum*, which is very similar in appearance has whitish or yellowish hairs on new growth.

Leaves: Green, large [9–35 (–40) cm long and 5.5–30 cm wide], shallow to deeply lobed (7–13), lobes pointed or rounded, dense covering of star-shaped hairs on underside with prickles (2–6 mm long) on mid-vein, leaves held alternately on stem; leaf stalks (1.5–6 cm long) greenish and covered with star-shaped hairs which are often reddish on new growth.

Flowers: White, star-shaped (3–4.5 cm across), in clusters of up to 50 or more flowers; flower stalks variable in length (3–15 mm long).

Fruits: Berries (fleshy fruits that do not open at maturity) (10–15 mm across), initially green turning yellowish-green, yellow or yellowish-orange as they mature; seeds are pale yellow (2.4–2.8 mm long).

ORIGIN
Costa Rica, Guatemala, Mexico, Nicaragua and Panama.

REASON FOR INTRODUCTION
Hedging, medicine and ornament.

INVADES
Disturbed areas, roadsides, urban open space, riparian zones, closed forests, and forest margins/gaps.

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IMPACTS

Can form stands to the detriment of native biodiversity. It is suspected of causing livestock poisoning and its sharp prickles can injure animals and people (Environmental Weeds of Australia, 2016). It is naturalized in the coastal districts of eastern Australia and Victoria (Environmental Weeds of Australia, 2016). In South Africa, it is invasive in the Eastern Cape Province where it has been used as a hedge plant (Henderson, 2020). In South Africa it invades grassland, savannah, forest margins, plantations, riverbanks and disturbed sites (Henderson, 2020).

Notes: Rarely seen on roadsides in Malawi and Zambia, but it can be confused with *S. torvum* which could account for the low records. According to Flora Zambesiaca it "may have been introduced to Africa from India a long time ago to protect cattle kraals against lions, but nowadays a potentially noxious weed." In Zimbabwe it is cultivated in gardens and "occasionally escaping, particularly around Mutare and Harare" (Flora of Zimbabwe, 2020).





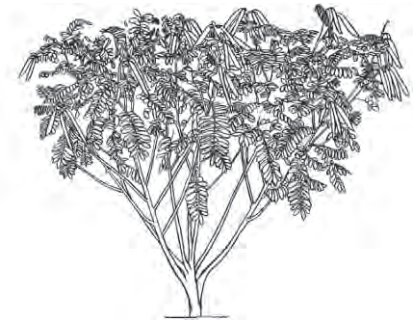


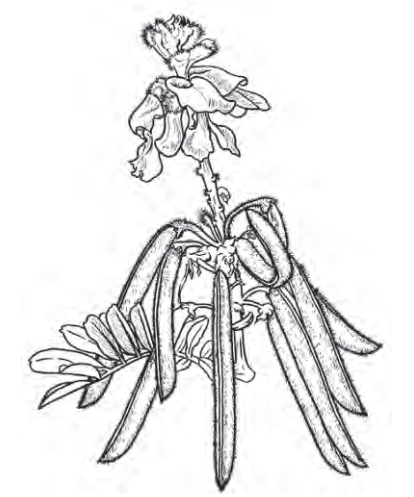


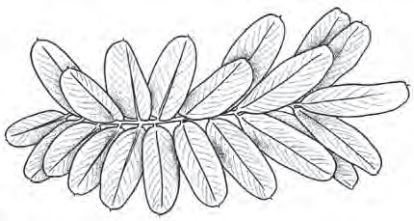


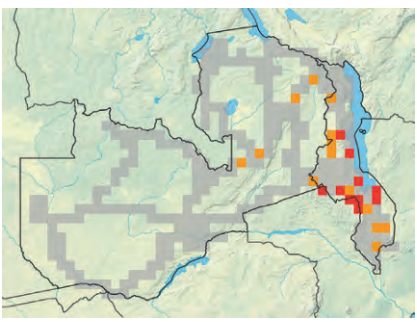
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Tephrosia vogelli Hook. f.









PEA FAMILY
Fabaceae; sub-family: Papilionaceae

COMMON NAMES
English: fish-poison-bean; fish-poison-tree, Vogel's tephrosia
Vernacular: buba, katupe, mtetezgia, mthuthu, ombwe

DESCRIPTION
Soft woody branching herb or small tree (1–4 m tall) with dense foliage; stems and branches densely covered with long and short white or rusty-brown hairs.

Leaves: Green, covered with short matted hairs above, more densely beneath; once-divided (8–23 cm long) with 13–29 oval to somewhat elongated or oval to sword-shaped leaflets (5 cm long and 2 cm wide) with pointed to rounded bases and tips rounded or with a broad shallow notch, held spirally on the stems.

Flowers: White, violet-purple or blue, in terminal clusters (8–26 cm long).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature (5.5–14 cm long and 0.8–1.8 cm wide), hairy, containing 6–18 dark brown to black oval seeds (7 mm long and 4.5 mm wide).

ORIGIN
Uncertain (Burkill, 1995), but an origin in Angola has been postulated (Kerharo and Bouquet, 1950). It is not considered to be native in the Flora Zambesiaca region (Mozambique, Malawi, Zambia, Zimbabwe, Botswana and the Caprivi Strip). Gillett *et al.* (1971) claim that its presence in East Africa and elsewhere on the continent may be due to its use as a fish poison.

REASON FOR INTRODUCTION
Nitrogen-fixation, poison (insecticide, fish), medicine and ornament.

INVADES
Roadsides, disturbed areas, fallow land, cropland, savannahs and grasslands.

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IMPACTS

T. vogelii has been found to have allelopathic impacts on three weed species (Wang *et al.*, 2011). Its leaves "are highly toxic to frogs and toads, molluscs, worms and insects" (Agbon *et al.*, 2004). The leaf extract is reportedly toxic to Nile tilapia (*Oreochromis niloticus* L.; Cichlidae). In southern Africa, *T. vogelii* is an alternate host for the groundnut plant hopper (*Hilda patruelis* Stal; Homoptera: Tettigometridae).

Notes: Widely promoted in Malawi and Zambia for nitrogen-fixation, it has escaped cultivation and was recorded as invasive in croplands and associated grasslands at a number of localities in Malawi. Probably more widespread in Zambia than indicated, with additional records from the outskirts of South Luangwa National Park (Astle *et al.*, 1997). Already used as an insecticide in Malawi more than 60 years ago (Williamson, 1954). The first herbarium specimen collected in Malawi was in 1966 in Blantyre District. Also reported to be present in both Malawi and Zambia by Drummond (1975). Found in disturbed and cultivated areas in Zimbabwe (Flora of Zimbabwe, 2020); naturalized in the central and eastern regions (Maroyi, 2012).





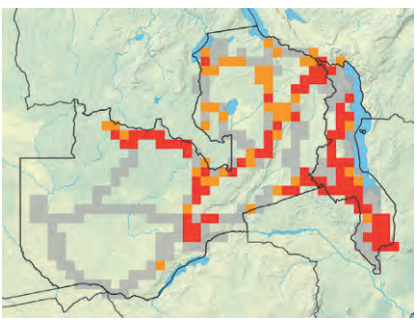




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Tithonia diversifolia (Hemsl.) A. Gray





DAISY FAMILY
Asteraceae

COMMON NAMES
English: Mexican sunflower, shrub sunflower, tree marigold

DESCRIPTION
Annual or evergreen herbaceous shrub, woody at the base [2–3 (–5) m tall]; young stems slightly ridged and hairy.

Leaves: Greyish-green, finely hairy beneath giving a grey appearance; simple (6–33 cm long and 5–22 cm wide) with 3–5 (–7) pointed lobes; margins with a series of curved projections or toothed; held opposite each other or alternately on the stems, on winged leaf stalks.

Flowers: Bright yellow, daisy or sunflower-like (to 10 cm across), held on long stalks (7–30 cm long) which are visibly swollen and velvety below the heads.

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown (4–8 mm long), in a brown spiky mass.

ORIGIN
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua and Panama.

REASON FOR INTRODUCTION
Medicine, fodder, mulch or green manure, soil improvement, hedge/barrier and ornament.

INVADES
Roadsides, disturbed sites, wasteland, fallow land, cropland, woodland edges/gaps, savannahs, lowlands and riparian vegetation.



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IMPACTS

Forms dense stands which can displace native plant species and the animals associated with them. Its production of numerous small, light seeds, coupled with its ability to spread vegetatively, allows it to invade and to establish readily and rapidly in new locations (Muoghalu and Chuba, 2005). In Nigeria, where it is displacing native vegetation in the wetlands of the Apete River, Eleyele Lake and Oba Dam near Ibadan, *T. diversifolia* is considered to be one of the most damaging of all invasive species (Borokini, 2011). There, it is reported to be out-competing even the formidable invasive shrub *Chromolaena odorata* (L.) King & H.E. Robins (Asteraceae) (Olubode *et al.*, 2011). Mexican sunflower has the ability to compete with agricultural crops (Illori *et al.*, 2010), and is contributing to the local extinction of valued native species, including some important medicinal plants (Oludare and Muoghalu, 2014). Surveys in Zambia revealed that *T. diversifolia* has negative impacts on native vegetation, mobility or access, water availability, crop yields and animal health (Witt *et al.*, 2019). Invasions have reportedly also led to the abandonment of some farms in the Copperbelt region of Zambia.

Notes: Often grown as a hedge it is widespread and invasive in much of Malawi and Zambia. Often forming large stands along roadsides, in urban open space, croplands, and riparian vegetation. In Malawi the first herbarium specimen was collected in 1966 in Blantyre District. Recorded as present by Phiri (2005) in the Zambian provinces of North-western, Copperbelt, Northern, Eastern and Lusaka. Also, previously reported as present in Malawi and Zambia by Drummond (1975). In Zimbabwe it is a "weed of roadsides and waste places" but much less common than *T. rotundifolia* (Flora of Zimbabwe, 2020).



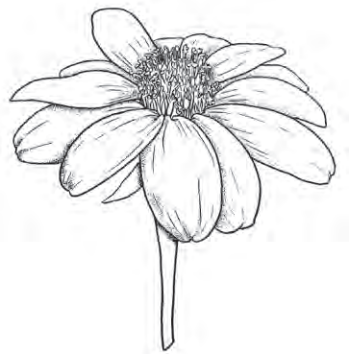




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Tithonia rotundifolia (Mill.) S.F. Blake







DAISY FAMILY
Asteraceae

COMMON NAMES
English: red sunflower

DESCRIPTION
Annual herbaceous shrub, slightly woody at the base [1.5–2 (–3) m tall].

Leaves: Dark green, rough, hairy, simple, triangular to egg-shaped (15 cm long and 10 cm wide), sometimes deeply three-lobed with bases broad and rounded, tapering towards the tips; margins with forward-pointing sharp or blunt projections or teeth; held opposite each other or alternately on stems, on winged leaf stalks.

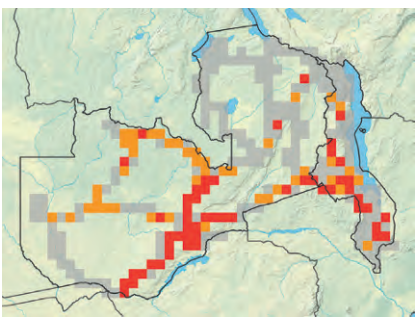
Flowers: Bright orange-red, daisy- or sunflower-like (90 mm across), solitary, held on long stalks which are visibly swollen and velvety below the heads.

Fruit: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown (4–8 mm long), in a brown spiky mass.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Hedge, honey source and ornament.

INVADES
Roadsides, wasteland, disturbed land, urban open space, drainage ditches, savannahs.





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IMPACTS

Like *T. diversifolia*, it has the ability to form dense stands, to the detriment of native flora and fauna. The heavier seeds of *T. rotundifolia* facilitate vigorous early growth in seedlings, resulting in quick establishment, while enabling the plants to grow in relatively resource-starved environments (Muoghalu and Chuba, 2005). Both *T. diversifolia* and *T. rotundifolia* have become serious weeds of "arable crops, plantations, abandoned lawns and roadsides in various parts of Africa", where, as "aggressive colonizers of new sites, they are probably adversely affecting the composition of the native flora and fauna, and altering ecosystem processes" (Muoghalu and Chuba, 2005).

Notes: Widespread and abundant in Malawi and Zambia. Invasive on roadsides, disturbed areas, urban open space, and croplands. In Malawi the first herbarium specimen was collected in 1970, in Lilongwe District. Found along roadsides and in damp, disturbed ground in Victoria Falls area (Pickering and Roe, 2009). Present in the Copperbelt, Central, Lusaka, and Southern Provinces of Zambia (Phiri, 2005). More than 50 years ago it was already recorded as a "tall annual weed of roadsides and waste ground in Zambia and Rhodesia" (Wild, 1968). It is now invasive in the northern, western, central and eastern regions of Zimbabwe (Maroyi, 2012).







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Tithonia tubaeformis (Jacq.) Cass



DAISY FAMILY
Asteraceae

COMMON NAMES
English: big-headed Mexican daisy, big-headed Mexican sunflower, giant Mexican daisy

DESCRIPTION
Erect branching annual or evergreen, 1 to 2 (–5) m high; stems reddish and covered in stiff hairs.

Leaves: Deep green above, paler beneath, egg-to wedge-shaped (7–18 cm long and 3.8–14.8 cm wide) with most other leaves much smaller and lance-shaped, 3-veined from base, margins toothed, very hairy, especially on veins, leaf stalks long (1.5–10 cm); unlike *T. diversifolia and T. rotundifolia* it does not have any lobed leaves.

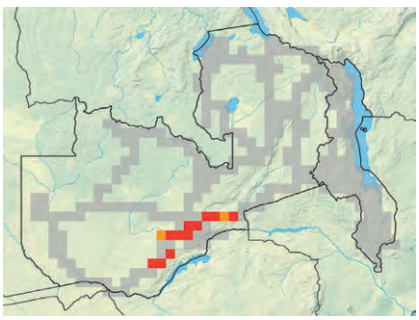
Flowers: Golden-yellow or orange petals (14), daisy- or sunflower-like, held on long swollen stalks (30 cm long); distinguished from other *Tithonia* species by having long and dense hairs on the whorl of bracts (leaf-like structures at the base of flowers).

Fruits: Achenes (small, dry, one-seeded fruits that do not open at maturity), brown (4–8 mm long), in a brown spiky mass.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Hedge, honey source and ornament.

INVADES
Roadsides, wasteland, disturbed land, urban open space, croplands, drainage ditches, and savannahs.



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IMPACTS

Forms dense stands, especially in fallow croplands and adjoining areas. Impacts would be similar to those recorded for other *Tithonia* species. It has become invasive in the humid and sub-humid tropics of Central and South America, and South-east Asia. It is also invasive in Swaziland and parts of South Africa (David Simelane, *pers. comm*.). *T. tubaeformis* is known to have invasive tendencies in its native range (Mexico), despite the presence of natural enemies. In the absence of natural enemies, *T. tubaeformis* is likely to become increasingly invasive throughout its introduced range, including southern Africa. Its ability to hybridize with *T. rotundifolia* (López-Caamal *et al.*, 2017) will exacerbate invasions.

Notes: Abundant in southern Zambia, especially along roadsides, croplands and often in fallow land. Not seen in Malawi but its rapid expansion in Zambia over the last 5–10 years should be cause for concern.











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SUCCULENTS

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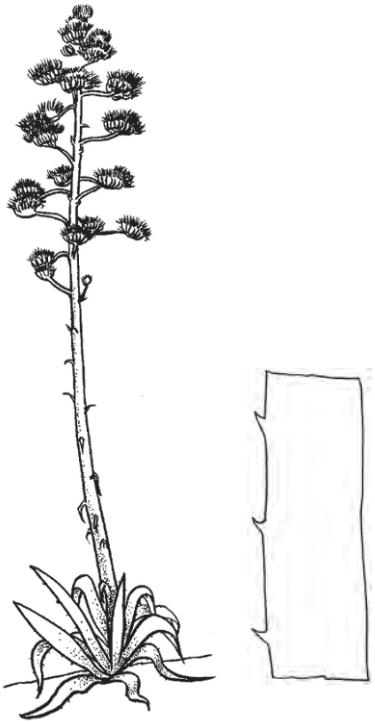


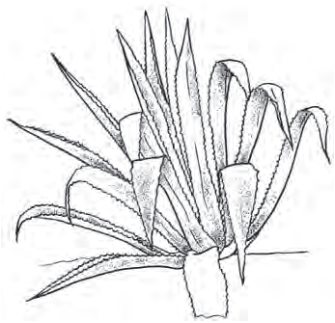


SUCCULENTS

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Agave americana L.





SISAL FAMILY
Agavaceae

COMMON NAMES
English: American agave, American aloe, century plant
Vernacular: khoje

DESCRIPTION
Succulent shrub with large leaves originating from a basal rosette (1–2 m high and 2–4 m across), with a flowering pole 5–12 m tall; does not produce plantlets (bulbils) on the flowering pole.

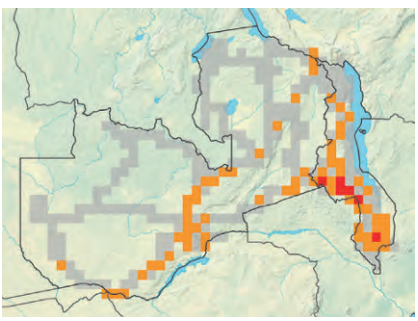
Leaves: Greyish-green, long and narrow, sword-shaped (1–2 m long and 15–25 cm wide), margins lined with sharp spines (to 1 cm long) and a terminal spine (3–5 cm long); variegated forms have grey to dark green leaves with yellow or white margins or central stripes; leaves erect at first, becoming reflexed, flopping over to one side in the case of *Agave americana* var. *americana*, but remaining erect to stiffly spreading in *Agave americana* var. *expansa*. *Agave sisalana* has relatively large dark green or greyish-green leaves (0.5–1.3 m long) without any prickles on their margins. *Agave angustifolia* has relatively large green, greyish-green or variegated leaves (0.5–1 m long) with many, relatively small vicious prickles (2–5 mm long) along their margins.

Flowers: Pale yellow (7–10 cm long), borne on flowering pole or stem.

Fruits: Capsules (dry fruits that open at maturity), green turning brown or black as they mature, large (4–5 cm long) with pointed tips.

ORIGIN
Mexico and southern USA.

REASON FOR INTRODUCTION
Flowering poles used in construction, fibre, hedge/barrier and ornament.



INVADES
Disturbed land, urban open spaces, drainage ditches, savannah, rocky outcrops and lowlands.

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IMPACTS

Spreads by suckering from the root crown, allowing one plant to form a dense, impenetrable stand over time, to the detriment of native plant species. Studies in Spain have shown that invaded areas harbour fewer native species than uninvaded areas (Badano and Pugnaire, 2004). In New Zealand it can smother small plants, especially in coastal and cliff areas, displace vulnerable dune species and alter the nutrient status of the soil (T.E.R:R.A.I.N., 2014). Thought to "pose a significant threat to rangeland biodiversity in Australia" it readily established in natural vegetation forming dense impenetrable thickets (Environmental Weeds of Australia, 2016). The sharp spines can injure people and animals, and may also restrict the movement of animals, while reducing the abundance of forage species. Plants contain calcium oxylate raphides (microscopic daggers of crystaline oxylate) as well as other irritating oils in the sap. Contact with the fresh sap can cause dermatitis and/or digestive problems in people. Sap from the spines and leaf tips may enter the skin through puncture wounds, which can become infected. Also naturalized in parts of Europe, the Canary Islands, southern China, southern Africa and New Zealand (Environmental Weeds of Australia, 2016).

Notes: Often spreading from established hedges, especially in Malawi. According to Flora Zambesiaca, *A. americana* is cultivated as an ornamental in a number of places throughout Malawi, including Lilongwe, Zomba, Mzuzu, Mangochi, Blantyre, and Dedza. An herbarium specimen, dated 1970, was collected at the foot of Nkhoma Mountain, about 50 km southeast of Lilongwe, Malawi. Another specimen, dated 1989, was collected in Zomba National Botanic Garden. Recorded as naturalized in central Zimbabwe (Maroyi, 2012).

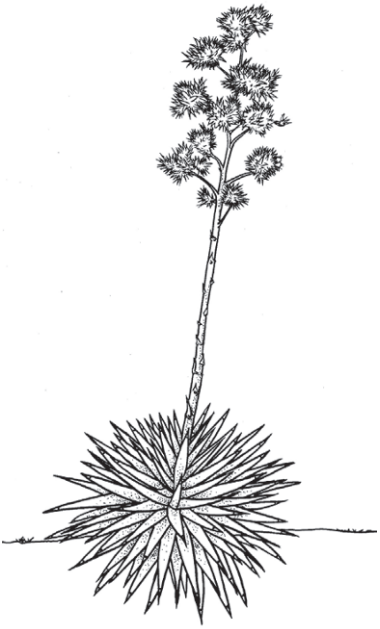






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Agave angustifolia Haw.







SISAL FAMILY
Agavaceae

COMMON NAMES
English: Caribbean agave, century plant
Vernacular: khoje

DESCRIPTION
Medium-sized perennial succulent shrub having leaves originating from a basal rosette, and with a branched flowering pole (inflorescence) (3–5 m tall); basal suckers; produces numerous plantlets (bulbils) on the flowering pole; has a more rounded appearance than *A. americana* or *A. sisalana*.

Leaves: Light green to pale bluish-green or greyish, linear to sword-shaped (0.6–1.2 m long); margins armed with vicious small teeth (2–5 mm long), with terminal leaf spine (1.5–3.5 cm long). There is also a variegated form with whitish or yellowish margins. *Agave americana* has very large greyish or variegated leaves (1–2 m long) with numerous, relatively large prickles (5–10 mm long) along their margins. *Agave sisalana* has relatively large dark green or greyish-green leaves (0.5–1.3 m long) without any prickles on their margins.

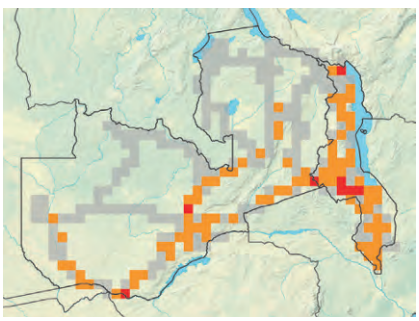
Flowers: Green to yellow, erect (5–6.5 cm long), in branched clusters along flowering pole.

Fruits: Capsules (dry fruits that open at maturity), egg-shaped (3–5 cm long).

ORIGIN
Belize, Costa Rica, El Salvador, Guatemala, Honduras, Mexico and Nicaragua.

REASON FOR INTRODUCTION
Fibre, hedge/barrier and ornament.

INVADES
Roadsides, wasteland, disturbed land, urban open spaces, plantations, drainage ditches, woodland gaps/edges, savannah, lowlands and gullies.



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IMPACTS

Has escaped from areas where it was planted as a living fence or ornamental, forming dense stands to the detriment of native flora and fauna. Regarded as an environmental weed in south-eastern Queensland, Australia, where it is considered to be one of the 200 most invasive plant species in the region; commonly "recorded on coastal sand dunes, sea cliffs and offshore islands" (Environmental Weeds of Australia, 2016). Also recorded as a weed of "roadsides, railway lines, disturbed sites, waste areas, abandoned gardens, urban bushland, riparian vegetation, hillsides and open woodlands in other parts of the region" (Environmental Weeds of Australia, 2016). As with other *Agave* species the sap is also allergenic. Individuals on social media who have been exposed to the plant sap have mentioned "itching hands and arms" and "legs and stomach covered with an instant burn and then blisters" followed by comments such as "demon" and "horror" and that "it will spread everywhere" (Dave's Garden, 2016). In South Africa it has invaded rocky outcrops and drainage lines (Henderson, 2001). Other impacts are similar to those of *A. americana* and *A. sisalana*.

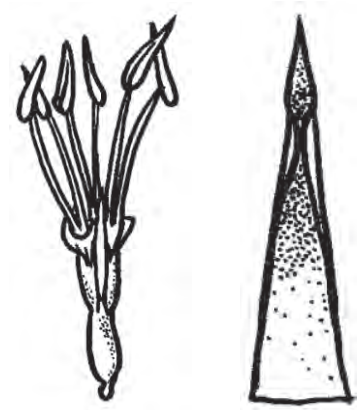
Notes: Often escaping from established hedges in Malawi and Zambia. Naturalized and invasive at a few localities in both countries. Has been present in Malawi for over 60 years making an "almost impenetrable hedge, even against big game" (Williamson, 1954).



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Agave sisalana Perrine





SISAL FAMILY
Agavaceae

COMMON NAMES
English: hemp plant, sisal hemp, sisal
Vernacular: bukuka, khoje, khonje

DESCRIPTION
Medium-sized to large succulent shrub with thick, sword-shaped leaves originating from a basal rosette with a branched flowering pole (5–6 m high); suckers from the base through elongated rhizomes; produces numerous plantlets (bulbils) on flowering pole.

Leaves: Dark green, linear or sword-shaped (0.9–1.3 m long), margin smooth, rarely toothed, but with terminal spine (2–2.5 cm long). *Agave americana* has very large greyish or variegated leaves (1–2 m long) with numerous, relatively large prickles (5–10 mm long) along their margins. *Agave angustifolia* has relatively large green, greyish-green or variegated leaves (0.5–1 m long) with many, relatively small vicious prickles (2–5 mm long) along their margins.

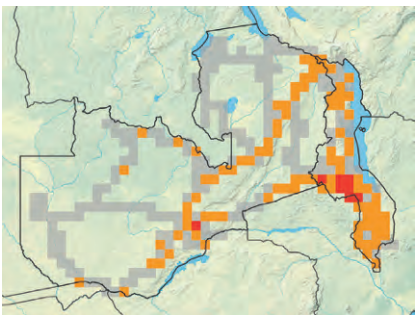
Flowers: Greenish yellow, erect (4–6 mm long), with reddish filaments to 6 cm long, in branched clusters along flowering pole.

Fruits: Rare to none; capsules (6 cm long and 2–2.5 cm wide), if present, usually have no seeds.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Flowering poles used in construction, fibre, bee forage, hedge/barrier and ornament.

INVADES
Disturbed land, wasteland, urban open spaces, plantations, drainage ditches, savannah, lowlands and gullies.



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IMPACTS

Suckering abundantly from the base, it can spread without reproduction from seeds. Also has bulbils which can contribute to spread. Out-competes and displaces native plants in semi-arid and arid environments, through more efficient exploitation of water and nutrients. *A. sisalana* often escapes from plantations into adjacent natural habitats, where it may form dense monospecific stands which reduce biodiversity and forage for native wildlife (Badano and Pugnaire, 2004). It threatens biodiversity at the UNESCO World Heritage Site of Aldabra Atoll in the Seychelles (van Dinther *et al.*, 2015). In Madagascar, sisal has invaded inselbergs, posing a serious threat to the indigenous vegetation (Porembski, 2000). Sisal also depletes soil fertility and reduces the pH of soils (Hartemink *et al.*, 1996; FAO, 2012). As with other *Agave* species, *A. sisalana* also has a toxic sap that causes pain and burning upon contact with skin, oftening leading to to blisters. If ingested, the saponin in the plant can cause kidney and liver damage. *A. sisalana* is also invasive in Australia, Madagascar, South Africa, USA, and on multiple islands in the Pacific (ISSG, 2015). In South Africa it invades savannah, erosion channels and watercourses (Henderson, 2001).

Notes: Has escaped cultivation from where it has been planted as a hedge, or a crop, in both Malawi and Zambia, but recorded as invasive in more localities in the former. Previously grown on a commercial scale in the Southern Province, and now on a smaller scale elsewhere in Malawi (Williamson, 1954). According to Bunderson *et al.* (2002) its "shallow, spreading adventitious root system can be competitive with nearby crops". In Malawi, the first herbarium specimen was collected in 1966 in Blantyre District, with another specimen collected in 1967 from Kirk Mountains, which borders Mozambique in the south of the country. Records from Zimbabwe indicate that it is naturalized in central Zimbabwe (Maroyi, 2012).

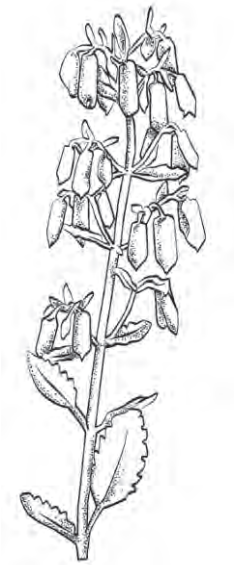




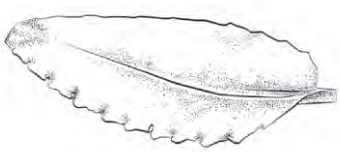


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Bryophyllum pinnatum (Lam.) Oken







SYNONYMS
Bryophyllum calycinum Salisb.; *Kalanchoe pinnata* (Lam.) Pers.

STONECROP FAMILY
Crassulaceae

COMMON NAMES
English: air plant, cathedral bells, green mother-of-millions, resurrection plant

DESCRIPTION
Evergreen, erect herb with succulent, hairless stems (50–200 cm tall), nearly woody below, simple or little branched, with red stripes or spots.

Leaves: Green, streaked with purple, edged with orange-red; fleshy, simple or with 3–5-leaflets (5–25 cm long and 2–12.5 cm wide); plantlets (bulbils) produced in the notches of leaf margins; leaf stalks broader towards the base (2.5–10 cm long).

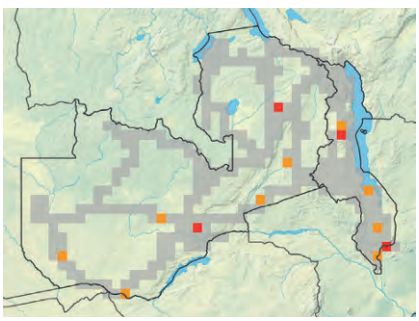
Flowers: Pale yellow to green with red to violet lines, becoming denser as the flowers mature, lantern-shaped (7 cm long), pendulous or drooping.

Fruits: Follicles (dry fruits having one compartment that opens, along one side only, at maturity), papery and membranous (about 15 mm long), with four compartments, containing numerous minute brownish seeds (about 0.8 mm long).

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed land, wastelands, urban open spaces, gardens, forest edges/gaps, woodland and woodland gaps/edges.



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IMPACTS

Readily establishes monospecific stands, to the detriment of native plant species (Weber, 2003). On Saint John, in the US Virgin Islands, large areas of herbaceous vegetation have been replaced by dense stands of *B. pinnatum* (Ting, 1989), and on the Galapágos Islands, thick carpets of *B. pinnatum* are preventing the regeneration of native plant species (Tye, 2001). The species is considered to be allelopathic, which may contribute to its invasion success, including its displacement of crops on the Galápagos Islands (Soria *et al.*, 2002). *B. pinnatum* is one of the three most prevalent invasive plant species recorded in rural humid areas on inhabited islands of the Galápagos (Guezou *et al.*, 2010). Like other *Bryophyllum* species, it is also toxic. Two adult cattle died within 48 hours of being fed large amounts of *B. pinnatum* plants (Reppas, 1995). Symptoms included hyper-salivation, ataxia, severe cardiac arrhythmia and laboured respiration (Reppas, 1995). *B. pinnatum* is also an alternative host for crop pests.

Notes: Preferring cooler localities with high rainfall, this species has escaped cultivation in some areas establishing small stands, especially in riparian areas and forest edges/gaps. According to Flora Zambesiaca it was first recorded in the District Commissioners Garden in Mulanje, Malawi, in 1965. Also naturalized in the central and eastern regions of Zimbabwe (Maroyi, 2012).









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Bryophyllum proliferum Bowie ex Hook.





SYNONYMS
Kalanchoe prolifera (Bowie ex Hook.) Raym.-Hamet

STONECROP FAMILY
Crassulaceae

COMMON NAMES
English: blooming boxes, green mother of millions

DESCRIPTION
Evergreen succulent, erect (to 3 m tall); stems almost woody, robust and four-angled (to 5 cm in diameter).

Leaves: Green, fleshy, once-divided (to 30 cm long), with 7–11 asymmetrical, somewhat elongated, sword- to egg-shaped leaflets (7–15 cm long and 1.5–5 cm wide), margins often purple and blunt/rounded to tooth-like; leaf stalk (to 16 cm long) broadened near base.

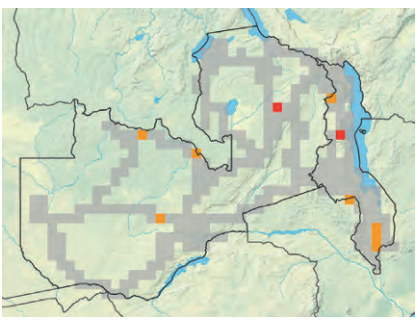
Flowers: Greenish-yellow with pinkish-red tips, bell-shaped, pendulous.

Fruits: Not seen in East Africa.

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Medicine and ornament.

INVADES
Roadsides, disturbed land, gardens, urban open space, forest gaps/edges and woodland gaps/edges.



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IMPACTS

Forms dense stands which exclude plants of native species and the organisms associated with them. Produces large numbers of bulbils on its inflorescence, facilitating invasions, and establishes easily from discarded plant material. Considered to be naturalized in South Africa (Walters *et al*., 2011). Many impacts are considered to be similar to those of other *Bryophyllum* species.

Notes: Grown as an ornamental it has established self-sustaining populations away from human habitation along forest edges/gaps, and in urban open spaces. Recorded as invasive at one locality in each of Malawi and Zambia. According to Maroyi (2012) it is a casual alien in the central region of Zimbabwe.



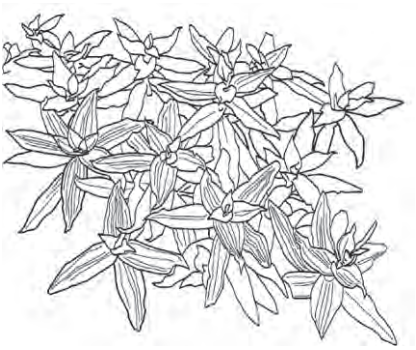






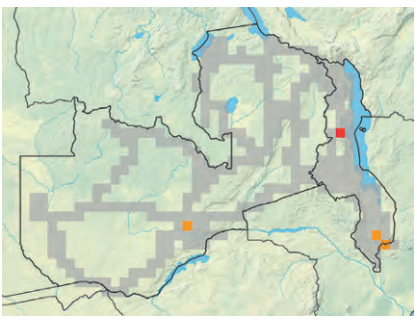
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Callisia fragrans (Lindl.) Woodson









SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES
English: basket plant, inch-plant, purple succulent

DESCRIPTION
Evergreen herbaceous plant, low-growing and spreading; stems (to 1 m long) fleshy, developing into long runners that produce roots, giving rise to new plants; flowering stems upright (to 1.5 m high).

Leaves: Green, purplish-green or purplish, hairless, elongated (5–40 cm long and 2.5–10 cm wide), tips pointed; clustered towards the ends of the stem, scattered below.

Flowers: White, small, showy, arranged in clusters of three on top of long erect stalks, fragrant.

Fruits: Capsules (dry fruits that open at maturity), tiny, with three cells.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Ornament.

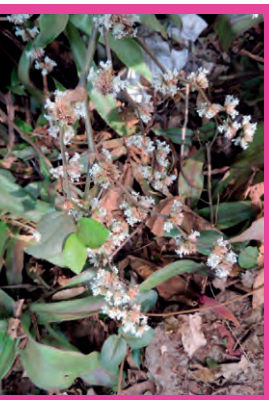
INVADES
Disturbed areas, wastelands, urban open spaces, gardens and areas adjoining urban settlements.

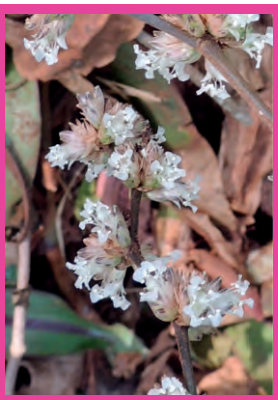
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IMPACTS

C. fragrans tends to grow in disturbed secondary forest and moist semi-open areas. It has also become invasive in the World Heritage Site of Gros Piton on Saint Lucia, Caribbean, forming extensive "carpets" in forest understoreys, replacing native Caribbean species such as *Callisia repens* Jacq. L (Commelinaceae); *Peperomia trifolia* (L.) A. Dietr. (Piperaceae); *P. myrtifolia* (Vahl) A. Dietr. (Piperaceae), and *Gibasis geniculata* (Jacq.) Rohw. (Commelinaceae) (Graveson, 2012). In parts of Australia, *C. fragrans* forms a dense, spreading ground-cover that can rapidly overtake bushland areas, crowding out native species and preventing their regeneration. In south-eastern Queensland, it is regarded as a significant environmental weed in many areas, including the Hervey Bay Local Authority Area, where it is regarded as one of the 12 "most concerning" environmental weeds (BCC, 2015). In dogs that come into contact with the plant, it can cause cell-mediated contact dermatitis (Lee and Mason, 2006). Some social media comments regarding the invasive nature of this plant are "it almost took over my yard when I first planted it" and "this plant is all over the place."

Notes: Probably more widespread, especially as an ornamental, than indicated in the distribution map. Found to have escaped cultivation at one site in northern Malawi where it has established widely in the understorey of an abandoned pine plantation. Prefers cooler climes with high rainfall.







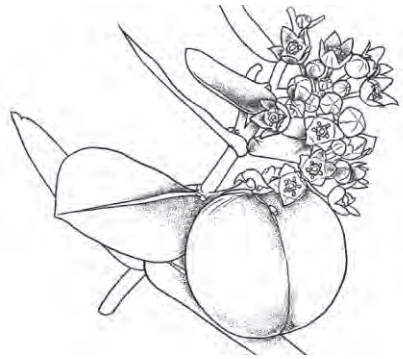


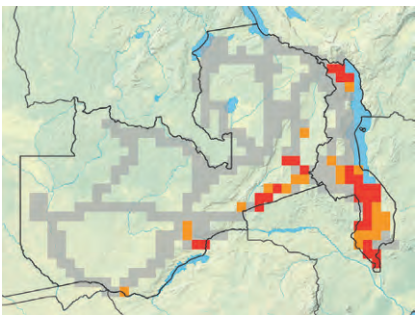
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Calotropis procera (Aiton) Dryand.









MILKWEED FAMILY
Apocynaceae

COMMON NAMES
English: apple of Sodom, cabbage tree, calotrope, calotropis, rubber bush
Vernacular: chitonje, letaunde, mpila

DESCRIPTION
Large shrub or small tree (2–4 m tall); stems waxy, with large leaves containing a milky sap; deep taproot (3–4 m in length).

Bark: Younger stems greyish-green, smooth, with a covering of whitish hairs, older stems have a cork-like bark, light brown in colour.

Leaves: Greyish-green, waxy, thick, hairless on top and hairy on undersides, with a broad, light yellow mid-vein, rounded or egg-shaped (5–30 cm long and 4–15 cm wide), margins entire with short-pointed tips, held opposite each other on stem, with stem-clasping bases, very short leaf stalks (5 mm long).

Flowers: Five white to pink petals (part of a flower that is usually brightly coloured) with dark purple or purplish tips (15–25 mm across), held in clusters, each containing 3–15 flowers; *C. gigantea* has white to pale lilac-blue petals that are bent backwards.

Fruits: Follicles (dry fruits with one compartment opening, along one side only, at maturity), bladdery or inflated, greyish-green turning brown as they mature, rounded to egg-shaped (6–12 cm long and 3–7 mm wide), containing numerous seeds (7 mm long and 5 mm wide), each with a tuft of long, silky hairs.

ORIGIN
Uncertain, but its postulated native range may include South West Asia (Afghanistan, Arabia, India, Iran, Jordan and Pakistan), and Africa (Algeria, Egypt, Libya, Morocco, Mauritania, Senegal and Somalia) (Parsons and Cuthbertson, 2001). However, some are of the opinion that it has a wider native range in Africa, including countries such as Ethiopia, Kenya, Tanzania and Uganda.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, gullies, pastures, dry riverbeds and floodplains.

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IMPACTS

Forms large and dense thickets, especially along roadsides and in low-lying areas, displacing native species. It has considerable environmental plasticity, being able to tolerate adverse climatic conditions and a wide range of soil types (Farahat *et al.*, 2015). In Australia, it competes with valuable forage species and is capable of forming dense thickets that interfere with stock management, particularly mustering activities (Smith, 2002). In Brazil, the species has invaded tropical rainforest and seasonally dry forest (Ferreira and Gomes, 1976; Barbosa *et al.*, 2007. The plant sap can cause severe irritation if it comes into contact with the eyes, resulting in immediate severe "corneal damage with painless sudden dimness of vision" (Basak *et al.*, 2009). Ingestion by livestock is suspected of causing ill-health and sometimes even death (Mahmoud *et al.*, 1979; de Lima *et al.*, 2011).

Notes: More than 70 years ago it was recorded in Malawi along the lake "often on the sites of former villages" (Williamson, 1954). The first herbarium specimen was collected in 1937 in Machinga District, with another specimen collected in 1941 in Mangochi, both in southern Malawi. In Zambia it is present in the provinces of Luapula, Northern, Eastern, Lusaka, and Southern, often found in the Luangwa and Zambezi valleys (Phiri, 2005). In Zimbabwe it has "become quite widely naturalised and somewhat invasive in places" (Flora of Zimbabwe, 2020). According to Maroyi (2012) it is naturalized in the northern, eastern and southern regions of Zimbabwe.



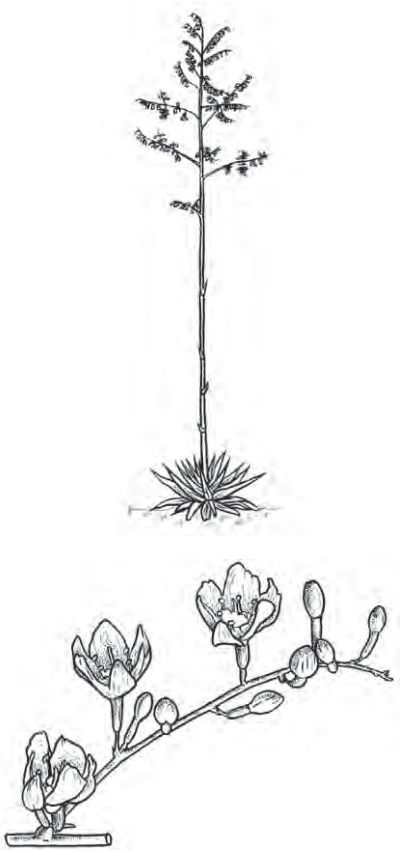


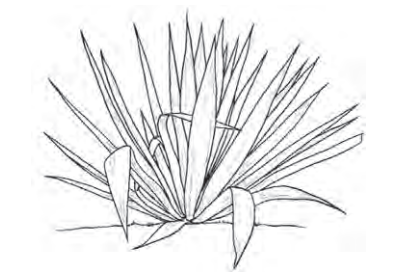




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Furcraea foetida (L.) Haw.





SYNONYMS
Agave foetida L; *Furcraea gigantea* Ventenat

SISAL FAMILY
Agavaceae

COMMON NAMES
English: furcraea, green aloe, Mauritius hemp

Vernacular: khoje wachizungu

DESCRIPTION
Large, short-stemmed evergreen succulent shrub with stiff, sword-shaped leaves originating from a basal rosette; has a branched, robust, hairless flowering pole (5–12 m high), on which numerous plantlets (bulbils) are produced.

Leaves: Light green to yellowish-green, elongated (1.2–2.5 m long and 7–20 cm wide); margins hard, distally smooth, with a sharp brown spine (4–8 cm long) and a few hooked, simple teeth or hooked prickes (4–10 mm long) towards the base.

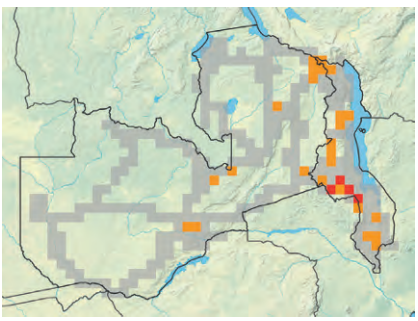
Flowers: White to greenish-white, pendulous (3.5–4 cm long and 4–4.5 cm across), in large branched clusters (1–6 m long) towards the top of the flowering pole.

Fruits: Capsules (dry fruits that open at maturity) are rare; spread mainly by plantlets (1–16 cm long).

ORIGIN
Brazil, Bolivia, French Guiana, Guadeloupe, Guyana, Martinique and Surinam.

REASON FOR INTRODUCTION
Barrier/hedge and ornament.

INVADES
Roadsides, urban open spaces, plantation edges, forest edges/gaps and savannah.



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IMPACTS

Often grown as a hedge plant, *F. foetida* has escaped cultivation and has established populations in the wild, to the detriment of native flora and fauna. It is dominant on many tropical islands, displacing surrounding vegetation. In Africa, it has invaded inselberg plant communities, which are known to support a high diversity of rare plants (Barthlott and Porembski, 1996; Fischer and Theisen, 2000). Invasions threaten bromeliad species and coastal plants of conservation concern in Brazil (Dechoum and Ziller, 2013), while an orchid, *Eulophia guineensis* Lindl. (Orchidaceae), rare on the island of Cape Verde, is threatened by *F. foetida* invasions (Marrero and Almeida Pérez, 2013). In Hawaii, the sub-shrubs *Schiedea apokremnos* H. St. John (Caryophyllaceae) and *S. spergulina* A. Gray var. *leiopoda* Sherff. are being displaced by *F. foetida* (USFWS, 2003; 2010). In Western Australia and Queensland, Mauritius hemp invades coastal sites and cliffs, gullies, hillsides and open woodlands, where it crowds out native species. In New Zealand, it is having a significant effect on indigenous plant communities.

Notes: Occasionally grown as a living fence in Malawi and Zambia it has on occasion escaped cultivation and established in the wild. According to Flora Zambesiaca it is "one of the commonest cultivated species" in Malawi. The first herbarium specimen collected in Malawi was in 1972 at Domasi College of Education in Zomba, followed by another specimen collected in 1981 on the edges of Chongoni Forest Reserve in Dedza. In Zimbabwe, it is "naturalised and sometimes forms fairly extensive colonies in secondary vegetation" (Flora of Zimbabwe, 2020).









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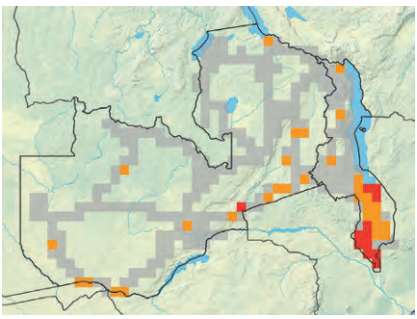
Jatropha gossypiifolia L.











SPURGE FAMILY
Euphorbiaceae

COMMON NAMES
English: American purging nut, bellyache bush, red fig-nut flower, red physic nut, wild cassava
Vernacular: gandafula

DESCRIPTION
Evergreen erect shrub [1–3 (–4) m tall]; older stems thick and succulent-like, young branches purplish and pubescent, exuding a brownish latex when damaged.

Leaves: Reddish-brown to dark bronze or purplish turning bright green with age, hairless, simple, usually 3 or 5 deep lobes (4.5–10 cm long and 5–13 cm wide), 3–5 veins from the base, margins glandular and minutely toothed; leaf stalks 6–9 cm long, covered in sticky hairs.

Flowers: Five dark red or deep purple petals (brightly coloured part of flower) with yellow centres, held in branched clusters (8–15 cm long) at the tips of branches.

Fruits: Capsules (dry fruits that open at maturity), glossy green turning brown as they mature, three-lobed, slightly hairy, somewhat elongated with almost parallel sides to almost round (about 12 mm long and 10 mm wide), containing three large light brown seeds.

ORIGIN
Antigua, Barbuda, Brazil, Bolivia, Colombia, Costa Rica, Dominica, Ecuador, Guadeloupe, Honduras, Mexico, Nicaragua, Peru, Paraguay, Puerto Rico, St. Kitts and Nevis, St. Lucia and Venezuela.

REASON FOR INTRODUCTION
Medicine, natural oils, hedge/barrier and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, drainage ditches, savannahs, lowlands, gullies and dry riverbeds.

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IMPACTS

This weed forms dense thickets, especially in riparian areas, where it readily displaces native plant species and prevents their regeneration. In Australia it readily establishes in disturbed habitats and is common in areas where the natural vegetation has been overgrazed or otherwise removed. Invasions in Australia are common in riparian zones, ephemeral water courses and pastures. According to Csurhes (1999), dense stands contribute to a loss in biodiversity and wildlife habitat, alter fire regimes, increase soil erosion and destabilize creek and river banks. By out-competing valuable forage species, it also significantly reduces the livestock carrying capacities of rangelands. The plant is also toxic, and may cause death if accidentally consumed by livestock. In 1995, 312 head of livestock (290 cattle, 7 horses and 15 goats) in northern Queensland died after consuming the plant during a drought (Csurhes, 1999).

Notes: Present in Malawi and Zambia it was often recorded as naturalized and/or invasive in southern Malawi, especially along roadsides, in dry riverbeds and floodplains. In Malawi, it has been cultivated for many years as a hedge plant, and for medicinal purposes in Zomba and the Lower Shire (Williamson, 1954). An herbarium specimen was collected in Ngabu Village in Chikwawa District, Malawi, in 1936. According to Flora Zambesiaca it was also recorded along the Nsanje Road in the Southern Region of Malawi in 1980. Present in the Northern Province, Zambia (Phiri, 2005). In Zimbabwe it has become naturalized near rivers and disturbed areas (Flora of Zimbabwe, 2020) in the northern, eastern and western regions (Maroyi, 2012).



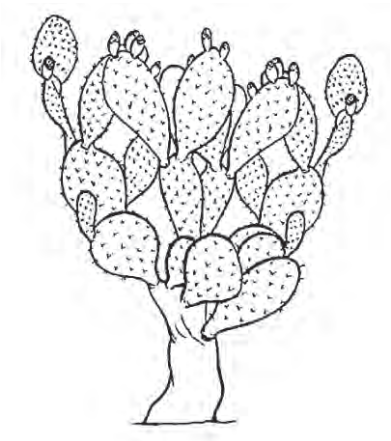


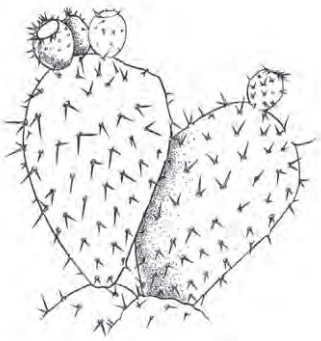


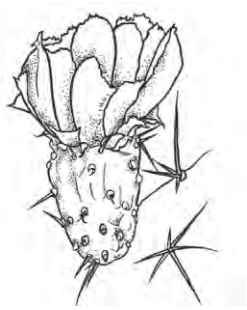


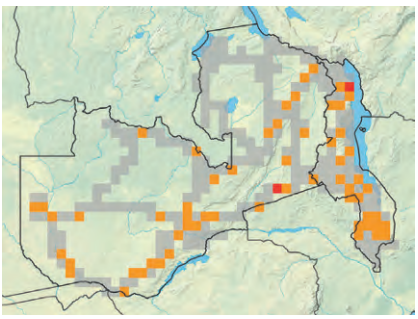
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Opuntia ficus-indica (L.) Mill.









SYNONYM
Opuntia megacantha Salm-Dyck

CACTUS FAMILY
Cactaceae

COMMON NAMES
English: cactus pear, Indian fig, mission prickly pear, prickly pear, sweet prickly pear

DESCRIPTION
Large succulent shrub or small tree [1.5–3 (–7) m tall], forming a trunk with age; modified stems (called cladodes) dull green or blue-green, flattened, much longer (20–60 cm) than broad (10–20 cm); spines (to 2.5 cm long) white or off-white, variable, one or more per areole [the raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines], spines sometimes absent.

Leaves: Minute, shed early.

Flowers: Orange or yellow, showy (2–3 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow, orange, red or purple as they mature, succulent, oval (5–10 cm long and 4–9 cm wide), with a pale pulp.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Edible fruits, fodder, hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, savannahs, dry and rocky places in arid and semi-arid regions.

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IMPACTS

Readily establishes large stands, displacing native plants and animals. Infestations can dramatically reduce the extent of forage available to livestock. In South Africa, this led to the abandonment of many farms early in the 20th Century. Beinart (2003) cites the example of a farmer in the Karoo, South Africa, who "lost control of prickly pear on his farm and was forced to sell" because the prickly pear infestations had become so dense that his livestock could no longer be herded and his sheep were dying. The glochids (barbed hairs or bristles) on the fruits cause internal swellings and sores if ingested, extending down the gullet to the internal linings of the digestive system, diminishing an animal's capacity to eat, and sometimes resulting in death (Beinart, 2003). The claim was made in 1893 that prickly pear was spreading so fast in South Africa that half the farming population of the Cape would be reduced to poverty if nothing were done. Additional impacts are assumed to be similar to those recorded for other invasive cactus species.

Notes: Widespread in Malawi and Zambia where it is often grown as a living fence and/or for its edible fruits. Rarely recorded as naturalized and/or invasive in either of these countries. Naturalized and invasive in many areas in Zimbabwe (Flora of Zimbabwe, 2020), especially in the central and southern regions (Maroyi, 2012).





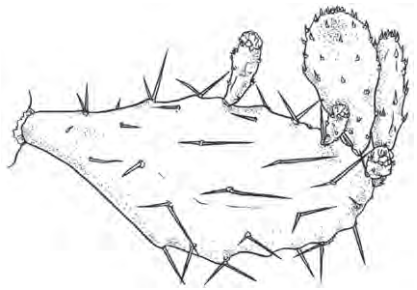


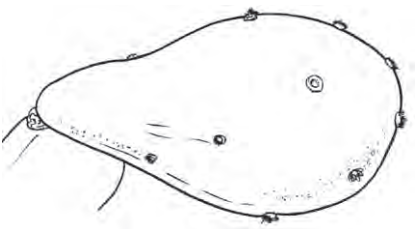


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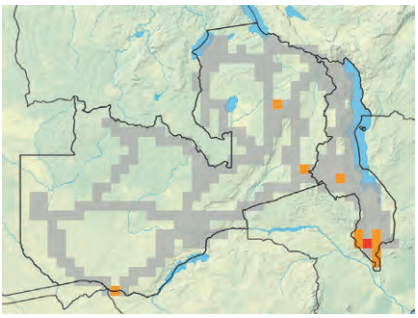
Opuntia monacantha Haw.











SYNONYM
Opuntia vulgaris sensu. auct. non Mill. (misapplied name)

CACTUS FAMILY
Cactaceae

COMMON NAMES
English: Barbary fig, cochineal prickly pear, common prickly pear, drooping prickly pear

DESCRIPTION
Succulent shrub or small tree [2–3 (–6) m tall], sometimes with a short trunk, usually large and much-branched on top with drooping upper segments; modified stems (called cladodes) bright green and shiny, especially when young, flattened, usually thin, egg-shaped to somewhat elongated with almost parallel sides [10–30 cm long and 7.5–10 (–12.5) cm wide], tapering towards the base; 1 or 2 (–3) spines per areole [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines], with numerous spines (2–4 cm long) on the trunks.

Leaves: Green, minute (2–3 mm long), cone-shaped, shed early.

Flowers: Yellow or orange-yellow, outer petals tinged with red (5–7.5 cm long and 7.5–10 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning light green to yellow with red-purple streaks as they mature, egg- to pear-shaped (about 6 cm long and 4–5 cm wide).

REASON FOR INTRODUCTION
Edible fruits, fodder, hedge/barrier and ornament.

ORIGIN
Argentina, Brazil, Paraguay and Uruguay.

INVADES
Roadsides, disturbed land, forest edges/gaps, woodland edges/gaps, savannahs and coastal bush.

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IMPACTS

Forms dense, impenetrable thickets, probably displacing native plant species. Infestations also inhibit access to natural resources such as grazing and water. Expansive stands reduce livestock carrying capacities. Pastoralists in Kenya claim that dense stands provide cover for dangerous animals, posing an added threat to livestock. One farmer near Thika, Kenya, claimed that he had lost many chickens to predators, which seek refuge in dense infestations. Additional impacts are assumed to be similar to those recorded for other invasive cactus species. Recorded as invasive in China, India, Philippines, Taiwan, South Africa, Hawaii, Australia, New Caledonia and New Zealand (CABI, 2016).

Notes: Less common than some of the other cactus species. Occasionally seen in Malawi and Zambia, and only recorded as invasive at one locality in southern Malawi where it had escaped from a living fence.





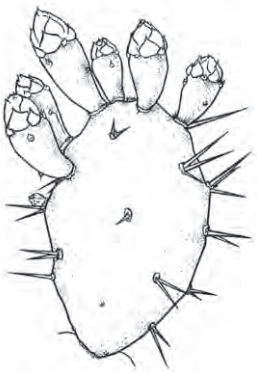


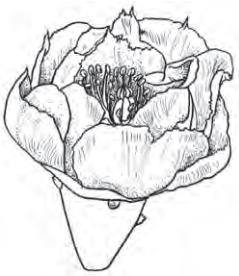


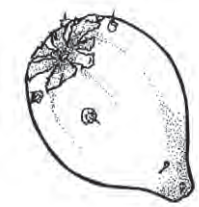
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Opuntia stricta (Haw.) Haw.









CACTUS FAMILY
Cactaceae

COMMON NAMES
English: Australian pest pear, common pest pear, erect prickly pear, sour prickly pear
Vernacular: kaloga, nkhaze

DESCRIPTION
Succulent erect, spreading shrub [0.5–1.3 (–2) m high]; thicket-forming; modified stems (called cladodes) blue-green, longer than broad (10–20 cm long and 7.5–14 cm wide); 3–5 areoles [raised structures or bumps on the stems (cladodes) of cacti, out of which grow clusters of spines] in a diagonal row on each cladode; 1 or 2 straight, flattened yellow spines (1.5–4 cm long), usually restricted to marginal areoles [as opposed to *O. stricta* (Haw.) Haw. var. *dillenii* (Ker Gawl.) Benson, which has 4–7 (–11) banded spines (1.5–4 cm long) on most areoles].

Leaves: Cylindrical, minute, shed early.

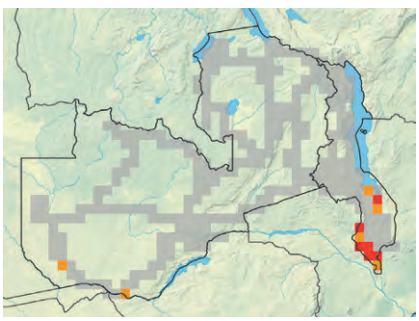
Flowers: Yellow, large (5–6 cm long and 5–6 cm wide).

Fruits: Berries (fleshy fruits that do not open at maturity), green turning red-purple as they mature, fleshy, egg-shaped (4–6 cm long and 2.5–3 cm wide), outer surface smooth with clusters of glochids (barbed hairs or bristles), narrowed at the base; pulp purple and sour; seeds white.

ORIGIN
Ecuador, Mexico, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Hedge/barrier and ornament.

INVADES
Roadsides, wastelands, disturbed areas, rocky outcrops, savannahs, grasslands and riverbanks in arid to semi-arid regions.



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IMPACTS

Can form dense stands, preventing access to homes, water resources and pasture. On Madagascar, *O. stricta* has invaded land used for crop and pasture production, and has encroached on villages and roads, impeding human mobility (Larsson, 2004). Here, the cactus has had a negative impact on native grasses and herbs, and it is even affecting trees by inhibiting their growth and regeneration (Larsson, 2004). The small spines (known as glochids) on the fruit, when consumed by livestock, lodge in their gums, on their tongues or in their gastrointestinal tracts, causing bacterial infections, while the hard seeds may cause rumen impaction, which can be fatal, and which often leads to excessive, enforced culling of affected animals (Ueckert *et al.*, 1990). Similar impacts have been recorded in Laikipia County, Kenya, where pastoralists have lost significant numbers of livestock (Shackleton *et al.* 2017). People who consume the fruits develop diarrhoea and may suffer from serious infections caused by the spines (Larsson, 2004). In Kenya, *O. stricta* infestations have resulted in the abandonment of farmlands.

Notes: Rarely seen in Zambia but widespread and abundant in the south of Malawi where it forms extensive stands, often growing together with *Prosopis juliflora* along roadsides and overgrazed pasture. Referred to as *O. dillenii* it was recorded in many villages particularly Mphunzi (Dedza), and Chintembwe (Kota Kota Hills) in Malawi more than 60 years ago (Williamson, 1954).









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Tradescantia zebrina Bosse







SPIDERWORT FAMILY
Commelinaceae

COMMON NAMES
English: inch plant, striped wandering Jew, wandering Jew

DESCRIPTION
Succulent evergreen herbaceous plant with spreading stems, hairless and purple-red, producing roots at the joints.

Leaves: Green, silver and purple longitudinal stripes on upper surface, with purple undersides, hairless; egg-shaped or broadly sword-shaped (3–7 cm long and 1.5–3 cm wide); margins entire, narrowing to a pointed tip; leaf-sheath (clasping tubular structure) (0.8–1.2 cm long) surrounds or encloses part of stem.

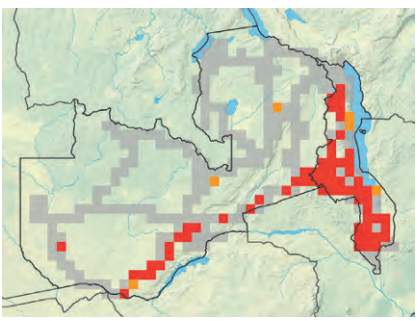
Flowers: Bright pink or purple, in small clusters at the tips of the stems.

Fruits: Capsules (dry fruits that open at maturity), small, seeds brown.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Ornament.

INVADES
Savannahs, roadsides, forest edges and coastal scrub.



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IMPACTS

Has the ability to form dense monospecific stands, displacing native plants and animals. It tends to grow in disturbed secondary forest and in moist semi-open areas. It also readily establishes in "waste areas, disturbed sites, roadsides, urban bushland, riparian vegetation, open woodlands and forests in sub-tropical and warmer temperate regions" (Environmental Weeds of Australia, 2016). It has become invasive in a World Heritage Site on Saint Lucia on the middle slopes of Gros Piton, where its dense carpets are displacing indigenous plant species such as *Peperomia trifolia* (L.) A. Dietr. (Piperaceae); *P. myrtifolia* (Vahl) A. Dietr.; *Callisia repens* (Jacq.) L. (Commelinaceae), and *Gibasis geniculata* (Jacq.) Rohweder (Commelinaceae) (Graveson, 2012). In a regenerating Atlantic Forest fragment, *T. zebrina* proved to be a strong competitor, influencing species richness and abundance (Mantoani *et al.*, 2013). In Australia, "it has formed dense infestations (up to 1 m thick) along the edges of rainforests, particularly near settlements" (Humphries and Stanton, 1992, in Csurhes and Edwards, 1998). Contact with the foliage can cause irritations of the skin (Floridata, 2012; Dave's Garden, 2013). Recorded as invasive on many Pacific Islands and in Australia, China, Philippines, Singapore, Taiwan, Canary Islands, Brazil and Portugal (PIER, 2009; CABI, 2016).

Notes: Grown as an ornamental it has escaped cultivation and is now naturalized and invasive at a number of localities in Malawi and Zambia, especially along roadsides and disturbed sites in urban areas. In Zimbabwe, it is "frequently cultivated as a ground cover in shaded gardens and occasionally escaping in high rainfall areas in shady disturbed ground" (Flora of Zimbabwe, 2020).







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TREES

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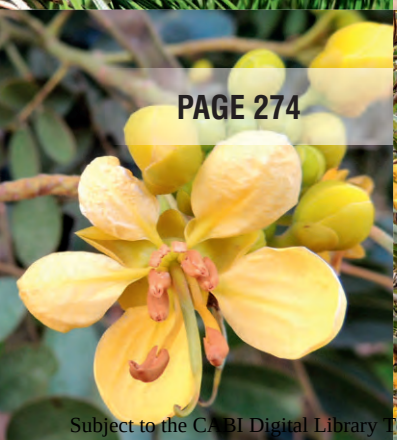
















TREES

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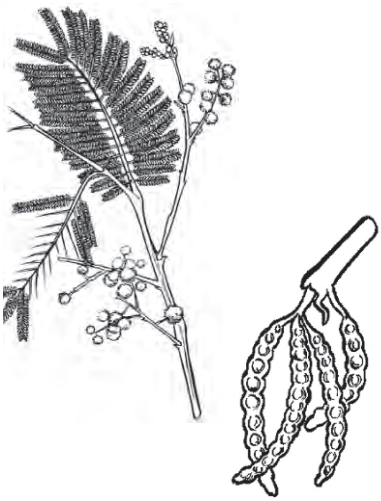
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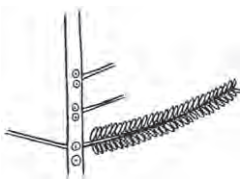
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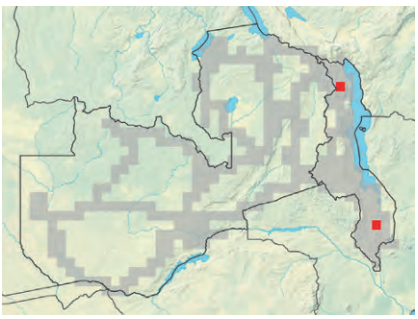
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Acacia mearnsii De Wild.









SYNONYMS
Acacia decurrens var. *mollis* Lindl.; *Racosperma mearnsii* (De Wild.) Pedley

PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: Australian acacia, black wattle, tan wattle

DESCRIPTION
Evergreen tree with no thorns/spines; round or shapeless [5–10 (–20) m high]; all parts finely hairy with growth tips golden-hairy.

Bark: Smooth, green-grey, later black and grooved, producing a brown resinous gum.

Leaves: Dark olive-green, twice-divided (8–12 cm long), 9–20 pairs of leaf branchlets (2–5 cm long), each with 20–60 pairs of leaflets (1.5–4 mm long); raised glands occur at and between the junctions of leaflet stalks along the whole midrib; held alternately on stems.

Flowers: Pale yellow or creamy in rounded heads or balls (5 mm across), fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, straight or twisted (6–15 cm long and 5–9 mm wide), usually constricted between seeds and finely hairy; seeds bean-like, flattened, black (4 mm long).

ORIGIN
South-east Australia and Tasmania.

REASON FOR INTRODUCTION
Fuelwood, building materials, shelter, ornamental, erosion control and tanning.

INVADES
Roadsides, disturbed land, wasteland, plantation edges/gaps, drainage ditches, forest edges/gaps, woodland edges/gaps, grassland, water courses, lowlands and gullies.



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IMPACTS

By shading out plants of native species, and by shedding large quantities of litter, black wattle reduces floral diversity (Weber, 2003), including grass communities and reduces the carrying capacity of the land (Sanakaran and Suresh, 2013). By fixing nitrogen, the species alters nutrient cycling, making soils unsuitable for some native plant species. In South Africa, costs associated with black wattle infestations include reduced stream flows, a heightened fire risk, increased erosion, destabilization of riverbanks, loss of grazing, nitrogen pollution, impairment of recreational activities, and diminished aesthetic appeal (de Wit, 2001). Losses in water runoff in South Africa, attributed to infestations of *A. mearnsii*, amount to an estimated 577 million m^3 of water annually (Versfeld *et al.*, 1998). *A. mearnsii* is considered to be the "most aggressive invader" of stream banks, forest margins and miombo woodlands above 1,600 metres above sea level in the mist belts of the eastern highlands of Zimbabwe. It has already invaded large tracts of land in the Nyanga and Chimanimani National Parks and in the botanical gardens of La Rochelle and Vumba. Black wattle is also extremely invasive in India, having invaded shola forests and associated grasslands.

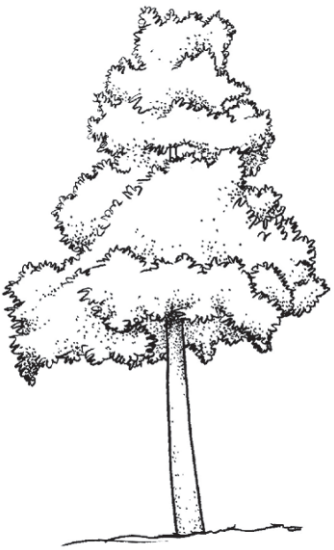
Notes: Only recorded at two localities in Malawi; Nyika National Park and Zomba Plateau. Locally abundant and spreading at both localities. We suspect that it may be present elsewhere in Malawi, and possibly also in Zambia. Herbarium records in Malawi indicate that the first specimen was collected in 1962 on the Zomba Plateau. A FAO report states that introductions to Zambia between 1950 and 1954 failed to establish, whereas CABI (2020) lists the species as present in Zambia. "An aggressive invader of grasslands and forest margins in high rainfall areas of Zimbabwe" (Flora of Zimbabwe, 2020). Recorded as invasive in eastern and central Zimbabwe (Maroyi, 2012).







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PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: Australian blackwood, blackwood, hickory, Tasmanian blackwood

DESCRIPTION
Evergreen tree with no thorns/spines; tall, conical or pyramidal [8–15 (–35) m high] with a straight trunk (0.5 m in diameter) and a dense crown.

Bark: Dark greyish to black and deeply fissured.

Leaves: Dark green to greyish-green, twice-divided on young plants and coppicing shoots; mature leaves are expanded leaf-stalks called phyllodes which are almost erect, straight to slightly curved, somewhat elongated (4–16 cm long and 6–30 mm wide) with 3–5 prominent longitudinal veins and fine net-veins in between; leaves held alternately on stems.

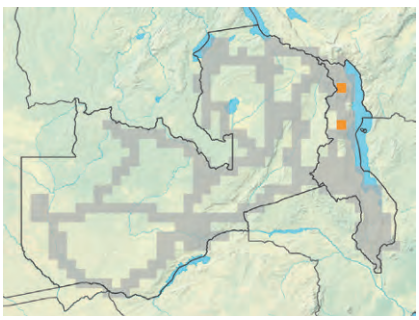
Flowers: Pale yellow, creamy or whitish in rounded heads or balls (5–10 mm across).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning reddish-brown as they mature, flattened and twisted or coiled (4–15 cm long and 3.5–8 mm wide); seeds almost encircled by a pinkish-red/orange fleshy structure.

ORIGIN
South-eastern and eastern Australia and Tasmania.

REASON FOR INTRODUCTION
Fuelwood, building materials, timber, erosion control, shelter and ornament.

INVADES
Roadsides, disturbed areas, plantations, drainage ditches, forest edges/gaps, grasslands, riparian areas and lowlands.





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IMPACTS

Forms dense thickets which may out-compete native plant species for water and light. Increases soil nitrogen levels, altering soil nutrient cycling. According to Souto *et al.* (1994), phenolic compounds released in the litter decomposition process inhibit germination and growth of other species contributing to low plant diversity in the understory of *A. melanoxylon* stands. Uses copious amounts of water, significantly more water than the native vegetation it replaces, changing soil moisture conditions (Rutherford *et al.*, 1986). *A. melanoxylon* is also considered to be one of the most "aggressive invaders" of montane grasslands in the eastern highlands of Zimbabwe. The montane grassland ecosystem, one of the most threatened habitats in Zimbabwe, is disappearing rapidly under a host of invaders. *A. melanoxylon* is also the cause of allergenic contact dermatitis and asthma in people who work with the wood. Other impacts are similar to those of *A. mearnsii* and other invasive *Acacia* species. Naturalized and/or invasive along the coast of south-western Western Australia; western Europe, including Belgium, France, Portugal and Spain; Kenya, Lesotho, South Africa, Swaziland and Tanzania in Africa; southern Asia including Bhutan, China, India, Pakistan and Sri Lanka; New Zealand; Hawaii; the west coast of the USA; La Réunion; Mauritius; the Azores (Environmental Weeds of Australia, 2016); and Argentina (CABI, 2016), Chile, Colombia, Mexico and Peru in Central and South America (PIER, 2012).

Notes: Recorded as naturalized at two localities in northern Malawi. Its presence in Zambia could not be confirmed. According to herbarium records in Malawi the first specimen was collected in 1968 in Dedza District, Central Province. Not recorded at this locality during surveys, an indication that it may be more widespead than indicated in the distribution map. Recorded as invasive in central and eastern Zimbabwe (Maroyi, 2012) where it has recently become "an invader of grasslands where it has proven to be much harder to control or eradicate than wattle" (Flora of Zimbabwe, 2020).







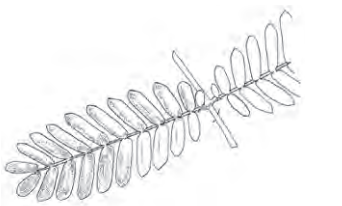


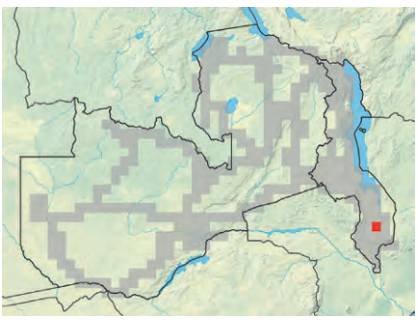
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SYNONYM
Acacia angustissima (Mill.) Kuntze

PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: Bolivian wattle, fern acacia, prairie acacia, prairie wattle, white-ball acacia

DESCRIPTION
Long-lived shrub or small tree (2–7 m tall), thornless, with a single short trunk with bent or flexible branches, younger branches almost round in cross-section with many small narrow ridges running lengthwise, hairless or covered with tiny coarse stiff hairs.

Bark: Brown or brownish-grey, smooth or slightly rough.

Leaves: Dull green above and below but slightly darker above, feathery, twice-divided (10–25 cm long), with few to several (10–25) leaflet branchlets, each with 30–60 or more pairs of nearly linear (3–4 mm long and 0.5–1 mm wide) leaflets, bluntly acute or pointed at the apex or terminal end with the base abruptly transverse as if cut-off, hairless except for margins which are fringed with hairs.

Flowers: Cream or whitish, fluffy, in small rounded or slightly elongated clusters (6–10 mm across), each containing 9–18 flowers; flower clusters on long stalks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), pale green and glossy turning reddish- or coffee-brown as they mature, linear to rectangular (4–8 cm long and 1 cm wide), flat and thin, hairless, with an abruptly pointed tip; seeds are mottled, pale green and brown, rounded, somewhat flattened (4 mm long and 3.5 mm wide).

ORIGIN
Argentina, Bolivia, Colombia, Mexico, Peru, southern United States and Venezuela.

REASON FOR INTRODUCTION
Fuelwood, fodder, medicine, soil restoration and nitrogen-fixation.

INVADES
Roadsides, disturbed areas, urban open space and fallow land.



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IMPACTS

Has the ability to form dense stands in a relatively short period of time, displacing native plant species. Invasions are facilitated by its prolific seed production, rapid growth, and its capability to reproduce vegetatively (Roshetko, 2001; Rico Arce and Bachman, 2006). This ability to grow quickly has resulted in prairie acacia becoming weedy and forming thickets, especially along roadsides and in sandy soil in pastures in its native range, including invasions in low deciduous forest (Rico Arce and Bachman, 2006). According to the World Agroforestry Centre (2021) this weed potential has created some concern about the advisability of its use in agroforestry or agricultural systems. It has been reported as invasive in Asia, Indonesia and Thailand, where it has spread forming thickets, with persistent seed banks (Gardiner *et al.*, 2008). Although its use has been abandoned in Australia due to its high invasive potential (Csurhes and Naïve, 2009; Environmental Weeds of Australia, 2016), it is still being actively promoted in various countries, mainly in Africa (Roshetko, 2001; Orwa *et al.*, 2009).

Notes: Only noted near Zomba, and along roadsides south of Zomba *en route* to Blantyre, where it has been planted and appears to have escaped cultivation. No herbarium records in Malawi and not listed in Flora Zambesiaca. Apparently, it has been planted in Zambia (Kaonga, 2012) but was not seen there during surveys. Present in Zimbabwe but its status there is unknown (Flora of Zimbabwe, 2021).



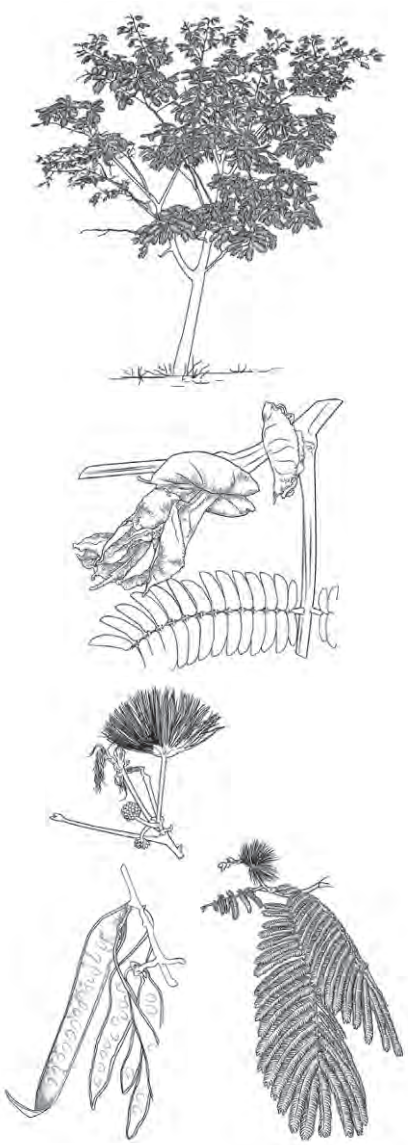


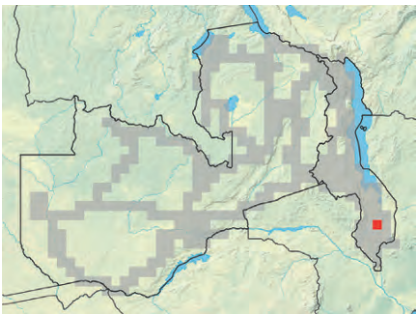




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Albizia chinensis (Osbeck) Merr.





PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: sau tree, sauce tree, silk tree, siris

DESCRIPTION
A large evergreen or deciduous (sheds its leaves annually) tree [20–30 (–40) m tall] with no thorns or spines, trunk diameter of 100–200 cm, mostly multi-stemmed, with a flat crown.

Bark: Dark grey, smooth and thin.

Leaves: Green, twice-divided with 4–14 (–20) pairs of leaflet branchlets (10–25 cm long), each with (10–) 20–30 (–45) pairs of leaflets (6–10 mm long and 2–3 mm wide) covered with very short fine straight erect to long cottony hairs, asymmetrical, with pointed terminal end or apex and blunt or rounded base; raised nectar glands (2–3 mm long and 1–1.5 mm wide) on the main leaf stem just below each pair of leaf branchlets.

Flowers: White, each 8–12 mm long, in heads (20–25 mm wide).

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning reddish- or yellowish-brown, flat and thin [(6–) 10–17 (–20) cm long and 1.7–3.5 cm wide], each containing 8–12 seeds; seeds oval and dark brown (7–10 mm long and 4–6 mm wide).

ORIGIN
Bangladesh, China, India, southeast Asia and Sri Lanka.

REASON FOR INTRODUCTION
Fodder, fuelwood, nitrogen fixation, ornament, timber, and shelter.

INVADES
Roadsides, disturbed areas, urban open space and forest gaps/edges.



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IMPACTS

Forms monocultures that shade out all competition, and alter the structure and composition of ecosystems (Speith and Harrison, 2012). According to Speith and Harrison (2012) it is "fast-growing and can displace vegetation preferred by threatened native birds, such as the purple-capped fruit dove (*Ptilinopus porphyraceus* Temminck; Columbidae) and the Pacific imperial pigeon (*Ducula pacifica* Gmelin; Columbidae)." Young leaves contain saponin and may be toxic to animals (Speith and Harrison, 2012). It is invasive in Hawaii, Mayotte and Samoa (CABI, 2020).

Notes: Promoted as an agroforestry species throughout much of Africa, including Malawi. Probably under-recorded in Malawi and Zambia with only one small stand seen near the town of Zomba in southern Malawi. In Zimbabwe, it is "planted as a shade tree on tea estates and locally escaping along forest margins and streambanks, where it appears to have the capacity to be invasive and become dominant" (Flora of Zimbabwe, 2021).









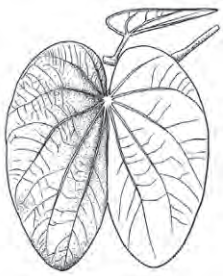


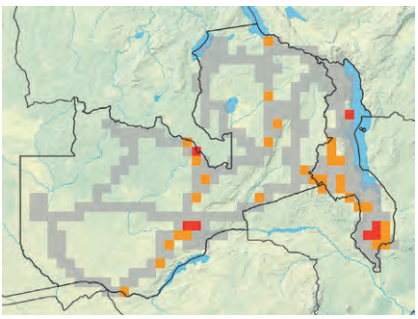
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Bauhinia variegata L.









SYNONYM
Bauhinia decora Uribe

PEA FAMILY
Fabaceae; sub-family Caesalpiniaceae

COMMON NAMES
English: bauhinia, camel's foot, orchid tree, purple orchid tree, white bauhinia
Vernacular: chitimbe, mpondo

DESCRIPTION
Fast-growing small to medium-sized tree (to 10 m tall) with a spread of 5 m; deciduous (sheds most or all of its leaves at the end of the growing season); trunk slender, topped with arching branches; canopy irregular in shape, crown moderately dense; twigs slender and angled.

Bark: Light brownish-grey, smooth to slightly fissured and scaly.

Leaves: Blue-green, hairless, veins prominent, simple with two heart-shaped lobes folded in the centre along the mid-vein, resembling a pair of butterfly wings (12 cm long and 12 cm wide), margins entire.

Flowers: White (in *B. variegata* var. *candida*) or deep pink marked with rose, crimson or yellowish-green (in *B. variegata* var. *variegata*) (8–10 cm across), 4 similar lower petals (part of flower that is usually brightly coloured) are wider near their tips, single upper petal usually wider near the base, petals (30 mm wide) overlapping, 5 fertile stamens (male reproductive organ); flower buds not ribbed, flowers during or after leaf-fall; not to be confused with *B. purpurea* L. which only has purple, red or pink flowers, petals which do not overlap, 3 fertile stamens, and ribbed flower buds.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green becoming dark brown as they mature (10–30 cm long and 1.5–2.5 cm wide), pointed tips; splitting open to release black oval seeds (1.2 cm long).

ORIGIN
Bhutan, China, India, Laos, Myanmar, Nepal, Pakistan, Thailand and Vietnam.

REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

INVADES
Roadsides, disturbed land, urban open spaces and savannah.



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IMPACTS

Forms dense monospecific stands, displacing native plant and animal species. It is considered to be an environmental weed in Australia, where it is invading and displacing native vegetation (Queensland Department of Primary Industries and Fisheries, 2011). In New Caledonia and Western Samoa it is invading insular forests (MacKee, 1994; Space and Flynn, 2002; PIER, 2014). It is also regarded as an invasive plant in Florida (USA), Cuba, and the Bahamas where it forms thickets in open forests and along roadsides (Langeland *et al.*, 2008; Oviedo Prieto *et al.*, 2012). In the USA it has been reported from a number of natural areas including the Loxahatchee National Wildlife Refuge and Everglades National Park where it displaces native vegetation (EPPC, 1996). Also invasive in savannah, coastal bush and urban open space in South Africa (Henderson, 2021).

Notes: Has escaped cultivation in Malawi and Zambia, occasionally forming dense stands, especially along roadsides. Of the herbarium specimens seen in Malawi the first was collected on Maone Estate in 1970, followed by one collected in Zomba Botanical Garden in 1975. The species is present in the Zambian provinces of Copperbelt, Central, Lusaka, and Southern (Phiri, 2005), where it is considered to be a "major invader, especially in mining areas" (Flora of Zambia, 2021). In Zimbabwe it "invades roadside ditches and disturbed areas" (Flora of Zimbabwe, 2020). According to Maroyi (2012) this species is naturalized in the western, central, and eastern regions of Zimbabwe.





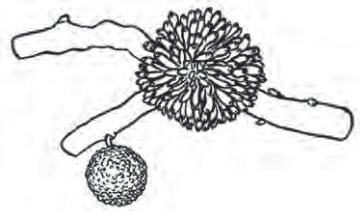




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Broussonetia papyrifera (L.) L'Hér. ex Vent.







MULBERRY FAMILY
Moraceae

COMMON NAMES
English: paper mulberry, tapa cloth tree

DESCRIPTION
Small tree or shrub (to 20 m or higher); trunk to 0.6 m in diameter; crown round or spreading; branches smooth and mottled grey, marked with orange-tan stipular scars; shallow rooted; exudes a milky sap when damaged; sheds most of its leaves at the end of the growing season.

Bark: Tan or light grey with pale orange to light tan stripes, becoming yellowish with age, smooth to slightly fissured.

Leaves: Greyish, rough surface above, fuzzy-downy below; simple (7–20 cm long), shape variable, either egg-shaped with a broad, rounded base tapering towards the end, or heart-shaped and deeply lobed, margins with forward-pointing fine projections or teeth; held alternately or almost opposite each other on stems; leaf stalks 3–10 cm long.

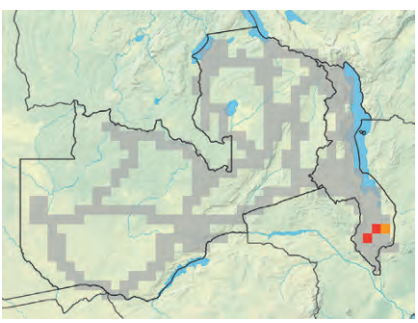
Flowers: Male flower yellowish-white, in clusters (3.5–7.5 cm wide); female flowers in rounded clusters, with round heads (about 1.3 cm wide), hairy.

Fruits: Multiple drupes or drupelets (fruits with a stony centre), 'fused' or clustered together, berry-like, green turning red or purple to orange as they mature, fleshy, round (1–2 cm across) with many embedded or protruding drupes.

ORIGIN
China, India, Japan, Korea, Malaysia, Pakistan and Thailand.

REASON FOR INTRODUCTION
Fuelwood, paper, pulp, fodder, shade and ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces, plantations, forest edges/gaps and riparian vegetation.



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IMPACTS

Forms dense stands which displace native plant species, prevent forest regeneration, and reduce water availability. In Pakistan, *B. papyrifera* limits the growth of *Dalbergia sissoo* Roxb. (Fabaceae); *Morus alba* L. (Moraceae), and *Ziziphus* spp. In the Philippines, paper mulberry has displaced native species such as *Trema orientalis* (L.) Blume (Cannabaceae); *Macaranga tanarius* (L.) Müll. Arg. (Euphorbiaceae); *Melanolepis multiglandulosus* (Reinw. ex Blume) Rchb.f. & Zoll. (Euphorbiaceae); *Mallotus philippinensis* (Lam.) Muell. Arg. (Euphorbiaceae); *Ficus nota* (Blanco) Merr. (Moraceae); *Ficus septica* Burm., *Ficus ulmifolia* Lam., and *Polyscias nodosa* (Blume) Seem (Araliaceae), among others (Baguinon *et al.*, 2003). Paper mulberry produces vast quantities of allergenic pollen, which has been shown to exacerbate asthma in sufferers. In Islamabad, Pakistan, paper mulberry can account for as much as 75% of the total pollen count, contributing to ill health or even death in the old and infirm.

Notes: Occasionally grown as an ornamental from where it has escaped and naturalized, forming small stands, especially along roadsides in some villages. The first herbarium specimen was collected in 1962 in Blantyre District, Malawi. Not seen in Zambia, but recorded as invasive at a few localities in the south of Malawi. It is also present in Zimbabwe (CABI, 2020).



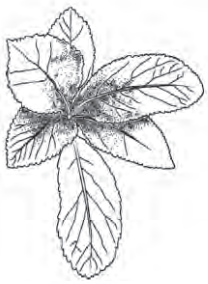




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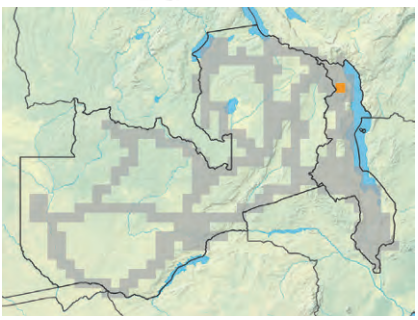
Crataegus mexicana Moc. & Sessé ex DC.











ROSE FAMILY
Rosaceae

COMMON NAMES
English: tejocote, manzanita, tejocotera, Mexican hawthorn

DESCRIPTION
Large shrub or small tree (5–10 m tall), with robust branchlets, straight and robust thorns (3.5–5 cm long), and a dense crown.

Leaves: Green, lance-shaped to oval [3.5–7.5 (−10) cm long and 2–5 cm wide] but sometimes shallowly 3-lobed, upper surface covered with short, soft hairs, lower surface also with hairs, mainly on the veins, leathery, toothed, terminal end pointed; leaf stalk short (0.1–0.6 cm long) and hairy.

Flowers: White (rarely pinkish) (0.7–1 cm long and 1.5–2 cm wide), in clusters of 3–12 flowers, petals (brightly coloured part of flower) round.

Fruit: Berries (fleshy fruits that do not open at maturity), green turning yellow to golden or copper-orange, fleshy, roundish (2 cm long and 1.5–3 cm wide), sepals (outer whorl of flower, often green and leaf-like in appearance) persisting at the crown (far end of fruit); seeds four to five [(1.2−) 1.5–2.5 cm in diameter].

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Crop, ornament, fodder, fuel, medicine, textile and metal industries.

INVADES
Disturbed areas, grasslands, and forest edges/gaps.

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IMPACTS

Forms dense, spiny thickets that displace and suppress other shrubs, thereby reducing native biodiversity. The thorns on the plant also impede movement, limiting access to useful areas. A congener, *C. monogyna* Jacq. is an aggressive colonizer known to be invasive in South Africa, Canada, USA, Australia and New Zealand (CABI, 2020). Invasions of this species displace native plants, and thickets alter the structure of the forest understorey. One protected area in Willamette Valley, Oregon, USA, was abandoned because of *C. monogyna* invasions (Alverson and Sigg, 2008), and it threatens the Garry Oak ecosystem of British Columbia, Canada. Some *Crataegus* species contain hydrocyanic acid in the leaves, which is poisonous to livestock.

Notes: Only known from Nyika National Park where it has escaped cultivation and is invading grasslands around Chelinda Camp. No other records.





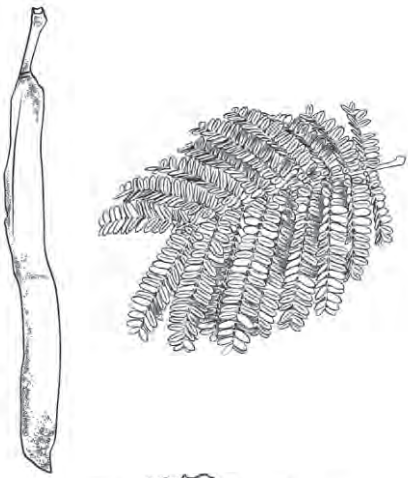




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Delonix regia (Hook.) Raf.







SYNONYM
Poinciana regia Hook.

PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: flamboyant, flame tree, peacock flower, Poinciana
Vernacular: mphamba

DESCRIPTION
Evergreen tree (to 18 m tall) with a spreading crown; trunk with buttress roots.

Bark: Smooth, pale brown or greyish, with vertical lines of brown spots.

Leaves: Light green, feathery, twice-divided (15–60 cm long), 7–20 pairs of leaflet branchlets, each bearing 10–35 pairs of small, somewhat elongated, almost parallel-sided leaflets (5–13 mm long and 2–5 mm wide).

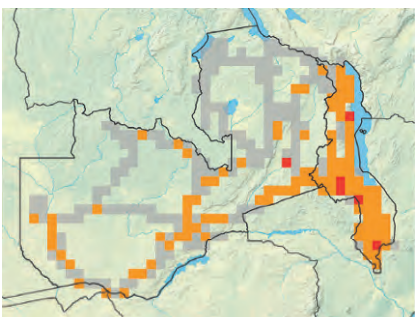
Flowers: Red/white, with five petals (4 red and 1 usually white blotched with red and yellow), held in clusters at the terminal ends of branches, showy.

Fruit: Pods (several-seeded dry fruits that split open at maturity), green turning brown or black as they mature, flat (30–60 cm long and 3–5.5 cm wide), soft when young, woody when mature; seeds brown and glossy (2 cm long).

ORIGIN
Madagascar.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open spaces and woodland edges/gaps.





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IMPACTS

Has the ability to form dense stands, possibly excluding native species. Seedlings germinate readily under parent trees, forming monospecific stands which compete strongly with other plants (PIER, 2009). It also has the ability to increase soil nitrogen levels, so impacting on soil nutrient cycling, negatively affecting species which thrive in low nutrient soils (Isaac *et al*., 2003). It has been recorded as invasive in the arid lowlands and moist uplands of the Galápagos Islands (McMullen, 1999), and in Hawaii it is naturalized at low elevation sites (Wagner *et al*., 1999). On Christmas Island (Indian Ocean), it has formed monospecific stands within disturbed marginal rainforest, where it is considered to be very competitive (Swarbrick, 1997). In the Northern Territory, Australia, it has invaded disturbed coastal monsoon vine thickets (Cowie, cited in Csurhes and Edwards, 1998). In Africa, it is considered to be invasive in Ghana (A.B.R. Witt, *pers*. obs.). In Ghana, seeds readily germinate under mature trees, forming a dense carpet of seedlings, to the exclusion of other species.

Notes: Was already widely planted as an ornamental across Malawi more than 60 years ago (Williamson, 1954). An herbarium specimen was collected in Malawi at Mangochi Boma in 1965. Based on our surveys it is common throughout much of Malawi and Zambia. Large trees can still be seen, especially along the lakeshore, where it is occasionally naturalized, and in some cases locally invasive. According to the Flora of Zimbabwe (2020) it "never appears to become naturalized."





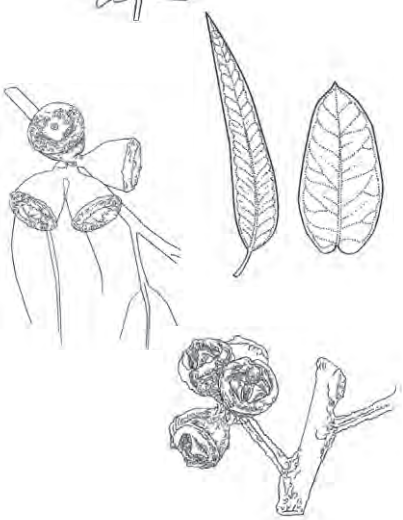


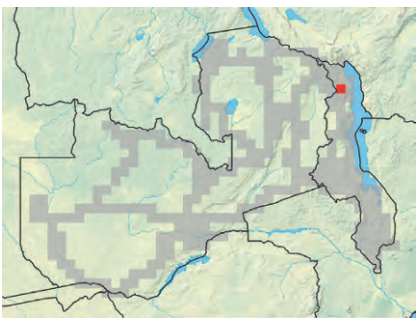


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MYRTLE FAMILY
Myrtaceae

COMMON NAMES
English: blue gum; southern blue gum; Tasmanian blue gum tree

DESCRIPTION
Evergreen, large tree [15–20 (–80 m) tall] with a straight trunk.

Bark: Greyish or brownish, rough, shedding in large strips and slabs; upper bark pale, smooth, often with a bluish or yellowish tinge.

Leaves: Seedling leaves are bluish-green on upper surface, lower surface white-waxy, egg-shaped (6–12 cm long and 2.5–7 cm wide), hairless, without stalks (base clasping the stem); juvenile leaves are also bluish-green, elliptic to egg-shaped (11–15 cm long and 6–11 cm wide), without stalks, held opposite each other on stems, stems of seedlings and juvenile leaf stalks are square in cross-section (round in *E. bridgesiana* R.T. Baker) and prominently winged; adult *E. globulus* leaves are lance-shaped (12–25 cm long and 1.7–3 cm wide), similar shade of green on upper and lower surfaces, leaf stalks are 1.5–3.7 cm long.

Flowers: White, simple, single flowered, buds (1–2.3 cm long and 1.4–2.8 cm wide) are top-shaped (turbinate), hairless, bud cap is flattened with a very distinctive central knob; *E. bridgesiana* bud cap is conical to beaked.

Fruits: Capsules (dry fruits that open at maturity), sub-globular to hemispherical (0.5–0.8 cm long and 0.6–1 cm wide), slightly ribbed longitudinally or not so, disc raised and slightly convex or level, 3 or 4 valves, exserted or near rim level; seeds black, brown or grey, egg-shaped (1.5–2.5 mm long).

ORIGIN
Southern Australia.

REASON FOR INTRODUCTION
Fuelwood, timber and ornament.

INVADES
Grasslands.



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IMPACTS

Producing copious amounts of seeds *E. globulus* can rapidly become a weed through seed escapes from plantations. High density stands displace native plant communities and alter habitat for birds and amphibians (CABI, 2021). In California, USA, the habitat of the threatened red-legged frog (*Rana draytonii* Baird & Girard; Ranidae), is being eroded by *Eucalyptus* species, whose aromatic leaves may be secreting toxic chemicals into the water. Two endangered plant species, also in California, *Areneria paludicola* B.L. Rob. (Caryophyllaceae) and *Nasturtium gambelii* (S. Watson) O.E. Schulz (Brassicaceae) are also threatened by *E. globulus* invasions (CABI, 2021). Other than the USA there are also invasions in South America, the Pacific Islands, New Zealand, and southern Europe (Sanz-Elorza *et al.*, 2001; Richardson and Rejmánek, 2011). In natural areas in Spain, the management of *Eucalyptus* spp. incurs the highest economic costs of all invasive plants (Andreu *et al.*, 2009).

Notes: *E. globulus* is naturalized around Chelinda Camp in Nyika National Park. We suspect that *E. bridgesiana* may also have escaped cultivation here but that observation needs to be confirmed. It should be noted that many of the *Eucalyptus* species introduced and established in Malawi are known to be invasive elsewhere. For example, *E. camaldulensis* Dehnh. (smooth, mottled, white or grey bark, often tinged with red; capsules with prominent rims and protruding triangular valves), *E. grandis* Maiden (bark smooth; flower buds pear-shaped with conical lids), *E. tereticornis* Sm. (smooth, white, grey or blue-grey bark; flower buds conical with bud lids 8-13 mm long; capsules with prominent rims and protruding triangular valves), and others, are known to be invasive in South Africa (Henderson, 2020). According to Maroyi (2012) *E. globulus* is invasive in the eastern regions of Zimbabwe, while species such as *E. camaldulensis*, *E. citriodora* Hook., *E. grandis*, *E. robusta* Sm. and *E. tereticornis* are frequently naturalized in Zimbabwe, especially in the east.









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PEA FAMILY
Fabaceae; sub-family: Papilionaceae

COMMON NAMES
English: gliricidia, Nicaraguan cocoa shade, quick-stick
Vernacular: kilisida

DESCRIPTION
Thornless medium-sized tree [2–15 (–20) m tall] with an erect trunk [5–30 (–100) cm in diameter], heavily branched, often from the base; crown spreading.

Bark: Initially smooth and green becoming greyish-deep brown with raised pores.

Leaves: Green with dark purplish tannin patches on lower surface, once-divided (15–30 cm long) with 6–24 opposite leaflets, oval or egg-shaped (4.4–8.3 cm long and 1.7–4.8 cm wide) with distinctive pointed tips, held alternately on the stems.

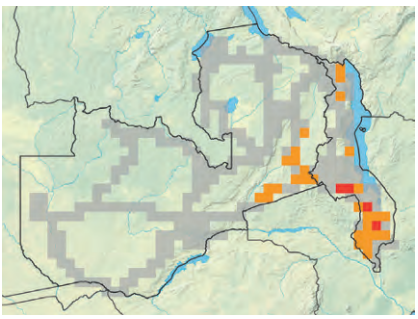
Flowers: Bright pink to whitish or purple with a yellow base, in clusters (4–8 cm long) of 30–100 flowers.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green but sometimes tinged reddish-purple turning yellow-brown as they mature, narrowly elongated (10–17 cm long and 1.4–2.2 cm wide); seeds (4–10), rounded, yellow-brown.

ORIGIN
El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, USA.

REASON FOR INTRODUCTION
Fuelwood, tool handles, nitrogen fixation, support for climbers (vanilla), restoration, windbreak, shade and ornament.

INVADES
Disturbed lands and savannah.



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IMPACTS

Has the potential to become invasive. In its native range, it is considered to be an "aggressive pioneer species" that forms monospecific stands "following slash and burn agriculture," but "in exotic locations, limited seed production, due to lack of pollinators, may limit its weed risk" (Simons, 1996a). That said, it is considered to be a "severe weed" in Jamaica (Simons, 1996b). It is also toxic, and its leaves and bark are reportedly used as a rodenticide in its native range, although this has been refuted by Gale *et al.* (1954). It may also be toxic or inhibit growth in animals such as rabbits and poultry, if ingested in sufficient quantities. High levels of nitrates in the plant are one of the suspected causes of 'cattle fall syndrome' in Colombia. The balance of evidence suggests that the plant may be toxic to non-ruminants, but conclusive evidence of toxicity to ruminants under normal feeding regimens is lacking. *G. sepium* also fixes nitrogen, and as such may alter natural nutrient cycling processes.

Notes: Widely grown for nitrogen fixation it has naturalized in some areas in Malawi and Zambia, and was recorded as locally invasive at a few localities in central and southern Malawi. Herbarium records in Malawi indicate that the first specimen was collected in Zomba Botanic Garden in 1975. Probably more widespread than indicated in the distribution map.

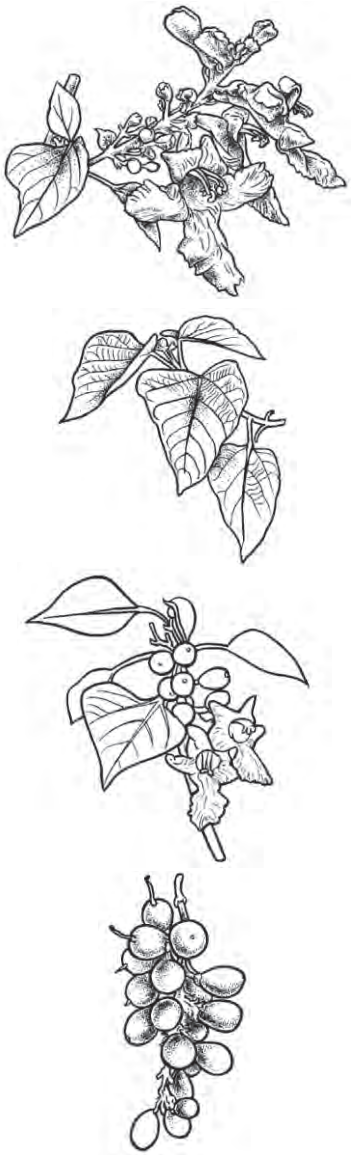








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MINT FAMILY
Lamiaceae

COMMON NAMES
English: gmelina, Malay beechwood, snapdragon tree, white beech
Vernacular: malayina

DESCRIPTION
Thornless medium to large tree [12–30 (–40) m tall] with an erect trunk (to 140 cm in diameter), branching over a wide area.

Bark: Smooth, greyish-yellow with black patches and conspicuous corky spots, thin.

Leaves: Green, velvety with yellow-brown hairs underneath, heart-shaped (10–25 cm long and 5–18 cm wide), margins entire on mature plants but strongly toothed or lobed on young plants; held opposite each other on stems, each pair at right angles to the pair below; leaf stalks round (5–15 cm long).

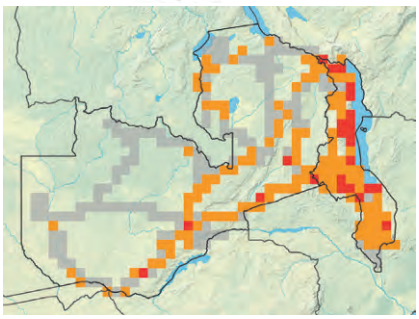
Flowers: Red, brown or yellow, large, funnel-shaped (4 cm long and 2.5–5 cm across) on a hairy stalk, in clusters (8–40 cm long), fragrant, showy.

Fruits: Drupes (fruits with a stony centre), orange-yellow, egg-shaped (2–3 cm long), surfaces hairy, containing 1–4 seeds.

ORIGIN
Bangladesh, Bhutan, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

REASON FOR INTRODUCTION
Fuelwood, light construction, pulp, fodder and ornament.

INVADES
Roadsides, disturbed areas, drainage channels, woodlands, savannah, lowlands and gulllies.





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IMPACTS

G. arborea establishes easily, grows rapidly, coppices readily, and is relatively free of pests outside of its natural range (Orwa *et al.*, 2009). In the Arnhem region of northern Australia, it is naturalizing around numerous settlements. It is also allelopathic; its leaf extracts inhibit the germination and growth of black gram, green gram, red gram and chickpea (Shankar *et al.*, 2014). In Sierra Leone, *G. arborea* has been found significantly to inhibit cowpea root growth at extractions of as low as 25% (Kamara, 2006).

Notes: Often grown in woodlots, this species has escaped cultivation and established dense stands, with multiple seedlings and saplings in the understorey. Seeds tend to be washed down gullies and waterways where they later establish. The first herbarium specimen in Malawi was collected in 1962 at Namlombwa Forest Reserve in Lilongwe District. According to Flora Zambesiaca it was planted as a street tree in Karonga Town in 1970. Probably more common in Zambia than indicated.







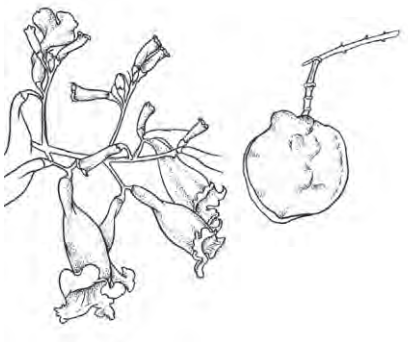


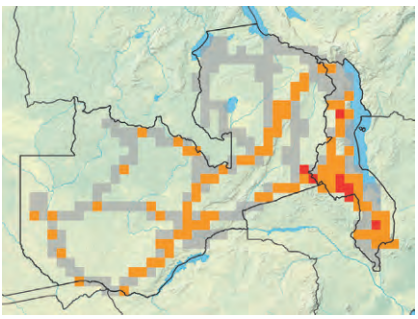
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Jacaranda mimosifolia D.Don









JACARANDA FAMILY
Bignoniaceae

COMMON NAMES
English: Brazilian rosewood, green ebony, jacaranda
Vernacular: jakaranda

DESCRIPTION
Medium-sized to large tree [5–15 m (–30) tall]; evergreen or deciduous (shedding most of its leaves at the end of the growing season); with a rounded, spreading crown; trunk (40–50 cm in diameter) short and often malformed; twigs light reddish-brown, slender and slightly zigzagged.

Bark: Thin, grey-brown, smooth in young trees becoming finely scaly and peeling with age.

Leaves: Dark green turning yellow in autumn/winter, feathery or fern-like, twice-divided (20–80 cm long) with 20–40 pairs of leaf branchlets, each with 19–45 sharply pointed leaflets.

Flowers: Lavender blue, rarely white, bell-shaped or tubular (3–5 cm long and 4–5 cm wide), in terminal clusters (20–30 cm long) at the ends of the branches.

Fruits: Capsules (dry fruits that open at maturity), green turning reddish-brown-black as they mature, woody with a wavy edge (5–7 cm wide), splitting on the tree to release many small winged seeds.

ORIGIN
Argentina and Bolivia.

REASON FOR INTRODUCTION
Fuelwood, timber, carving, shade and ornament.

INVADES
Roadsides, disturbed areas, urban open spaces, savannah and riparian vegetation.



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IMPACTS

J. mimosifolia has the ability to form dense stands, possibly displacing native plant and animal species. It is a "greedy feeder with an aggressive root system" (Maundu and Tengnäs, 2005). In South Africa, it is invading large tracts of land, affecting biodiversity and causing a reduction in water availability from rivers and streams (Carrere, 2000). It has been ranked as one of the biggest water users in South Africa (Le Maitre *et al.*, 2000). Elsewhere in southern Africa, *J. mimosifolia* has been recorded as invasive in the Matopos, Hwange and Kyle National Parks in Zimbabwe. It is also naturalized in the warmer parts of eastern Australia, Hawaii and south-eastern USA, as well as in parts of southern South America, outside its native range. On Rodos Island, Greece, it is regarded as a casual weed (Galanos, 2015).

Notes: Widely planted as an ornamental throughout Malawi and Zambia it was recorded as naturalized and invasive at a few sites. The first specimen was collected on the Zomba Plateau in Malawi in 1961. "Now frequently naturalised and sometimes quite invasive" in Zimbabwe (Flora of Zimbabwe, 2020), in the central, eastern and southern regions (Maroyi, 2012).





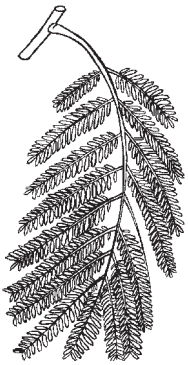


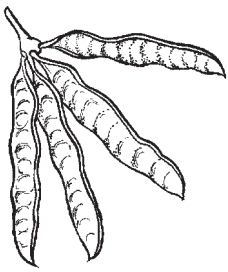


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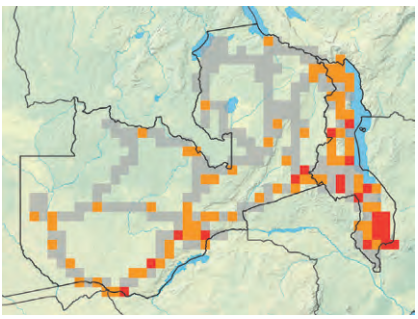
Leucaena leucocephala (Lam.) de Wit











PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: jumbie bean, lead tree, leucaena, wild tamarind
Vernacular: lukina

DESCRIPTION
Evergreen thornless shrub or small tree [2–10 (–15) m high]; young stems green and densely covered with greyish hairs.

Bark: Smooth, greyish-brown with numerous small raised spots.

Leaves: Dark green, often grey-hairy, twice-divided [70–150 (–350) mm long] with 3–10 pairs of leaf branchlets, each 2–10 cm long and bearing 5–22 pairs of somewhat elongated or sword-shaped leaflets (7–21 mm long and 1.5–5 mm wide) with almost parallel sides; there is usually a small raised structure (gland) on the leaf stalks.

Flowers: White or pale yellow, in round clusters (12–30 mm across), held singly or in groups of 2 or 3 at the junctures of the leaves and stems.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown or reddish-brown as they mature, elongated, almost straight (8–18 cm long and 2 cm wide), flattened but raised over the seeds, tips pointed; containing 10–25 hard seeds.

ORIGIN
Belize, Guatemala and Mexico.

REASON FOR INTRODUCTION
Fuelwood, fodder, tannins, nitrogen fixation, soil conservation, shade and ornament.

INVADES
Roadsides, disturbed land, urban open spaces, drainage ditches, forest edges/gaps, woodland edges/gaps, riparian vegetation, lowlands and coastal shrub.

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IMPACTS

Forms large monocultures, displacing native plant and animal species. In Hawaii, it is out-competing open forest species (Cronk and Fuller, 1995), while on the Brazilian island of Fernando de Noronha it is displacing the endemic flora. On Japan's Ogasawara (Bonin) Islands, leucaena infestations have severely affected native plant communities, altering secondary succession processes and facilitating establishment by other, more aggressive invading alien plant species (Yoshida and Oka, 2004). On Guam, infestations are preventing the regeneration of indigenous plant species (B. Lawrence, *pers. comm*., in Walton, 2003). On Vanuatu, where its infestations are threatening the native flora and "rendering extensive areas unusable and inaccessible", leucaena is proving "very difficult to eradicate" (Bakeo and Qarani, 2003). In Papua New Guinea, dense monospecific stands of leucaena in the Erap Valley, and alongside other rivers, are replacing the native riparian vegetation (G. Werren, *pers. comm*., in Walton, 2003).

Notes: Often grown in woodlots, or in croplands, for nitrogen fixation, it is naturalized and/or invasive at a number of sites throughout Malawi and Zambia. Herbarium specimens in Malawi were collected in 1970 at Ngoma Nursery at Chongoni in Dedza District and Makinja Village in Zomba District in 1978. Some stands may have been confused with *L. diversifolia* which is better adapted to most parts of Malawi than *L. leucocephala*, especially in the medium to higher altitudes (Bunderson *et al.*, 2002). Recorded as a casual alien in the northern, western, central and eastern regions of Zimbabwe (Maroyi, 2012).



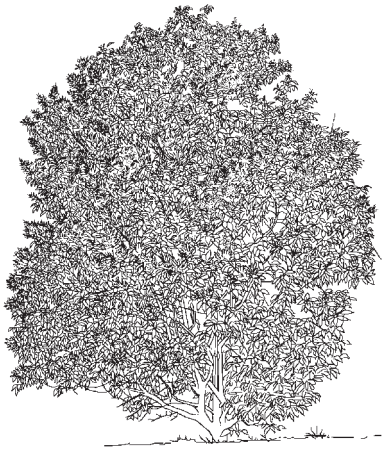


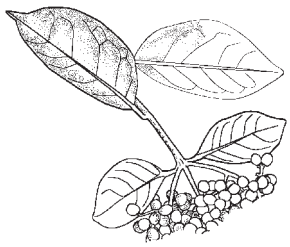




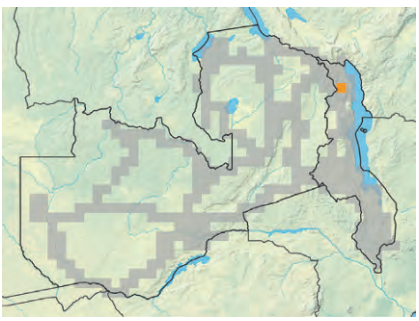
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Ligustrum lucidum W.T. Aiton









OLIVE FAMILY
Oleaceae

COMMON NAMES
English: broad-leaf privet, Chinese liguster, Chinese privet, glossy privet, Nepal privet, tree privet, wax-leaved privet

DESCRIPTION
Long-lived shrub or small tree [2–10 (–25) m tall].

Leaves: Dark green, glossy, egg- to oval-shaped (6–17 cm long and 3–8 cm wide), leathery or papery, hairless, base rounded but sometimes tapering gradually, apex or terminal end pointed or tapering gradually to a protracted point, held opposite each other; leaf stalks 10–20 mm long.

Flowers: White or creamy, tubular (1.5 mm long), in large broadly pyramid to cone-shaped terminal clusters (100–250 mm long and 200 mm wide), heavily scented.

Fruits: Berries (fleshy fruits that do not open at maturity), globular (7–10 mm long and 4–6 mm wide), green turning deep blue-black as they mature, shiny, in large clusters; seeds are oval-shaped (3–3.6 mm in diameter and 5–7 mm long), typically 1 or 2 per fruit.

ORIGIN
China and Korea.

REASON FOR INTRODUCTION
Barrier/hedging and ornament.

INVADES
Forests, woodlands and riparian vegetation.



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IMPACTS

Has the ability to form dense stands, displacing native plants and animals. Fast growing and long-lived (100 years) it can reach the tree canopy, and in the process, create conditions that impact negatively on native communities (Fernandez *et al.*, 2020). Invasions create low light conditions in the understory, "hampering the establishment and growth of most species of trees, shrubs and climbing plants, ultimately resulting in the dominance of *L. lucidum* and the exclusion of native species" (Fernandez *et al.*, 2020). According to Fernandez *et al.* (2020) invaded *L. lucidum* forests have lower plant species richness and diversity than native forests in similar ecosystems. In central Argentina *L. lucidum* invaded forest has approximately half the species richness of climbing plants when compared to native dry forest (Ferrero *et al.*, 2017). Bird species richness, diversity and abundance were also lower in *L. lucidum* invaded forest than in native secondary forest of similar successional age in northwest Argentina (Ayup *et al.*, 2014, in Fernandez *et al.*, 2020). *L. lucidum* has been reported as invasive in Argentina, Australia, Mozambique, South Africa and USA (CABI, 2021). It is widely believed to contribute to allergies and asthma and its fruits and leaves are poisonous (Henderson, 2020).

Notes: Not actively recorded in Malawi and Zambia so probably more widespread than indicated. Only found to be naturalized around Chelinda Camp in Nyika National Park. Herbarium specimens were collected in Chigumjula Forest Nursery in 1978; Mulanje Forest in 1982; and along the Likhubula River and Chigumura Nursery, both in 1987. It is known as a naturalized escape, particularly around Harare (Flora of Zimbabwe, 2021).









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Melia azedarach L.









MAHOGANY FAMILY
Meliaceae

COMMON NAMES
English: bead tree, Cape lilac, Persian lilac, pride of India, syringe, white cedar
Vernacular: indiya, indya, mkina

DESCRIPTION
Spreading tree (to 20 m tall), deciduous (sheds most or all of its leaves at the end of the growing season); bark on young stems reddish-brown and smooth.

Bark: Grey-brown and smooth becoming browner, rougher and furrowed with age.

Leaves: Deep green, glossy above turning yellow in autumn, twice-divided (50 cm long), 4–6 pairs of leaf branchlets, each bearing 3–6 sword-shaped, almost hairless leaflets (5 cm long and 2.5 cm wide), margins toothed.

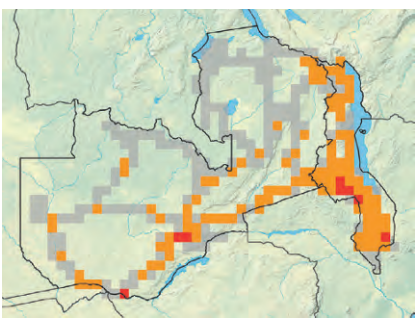
Flowers: Blue to mauve (15–20 mm wide), in large, axillary panicles or clusters, with a pleasant scent.

Fruits: Berries (fleshy fruits that do not open at maturity), green turning yellow and wrinkling as they mature, round (12 mm across), three-seeded, remain on trees after leaf-fall.

ORIGIN
Australia, China, India, Indonesia, Japan, Papua New Guinea and Sri Lanka.

REASON FOR INTRODUCTION
Fuelwood, building materials, medicine, shade and ornament.

INVADES
Roadsides, wasteland, urban open spaces, forest edges/ gaps and riverbanks.





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IMPACTS

Syringa has the ability to form dense, impenetrable stands, displacing native plant and animal species (Weber, 2003) and "impoverishing biodiversity" (Batcher, 2000). Its leaf litter increases soil pH and nitrogen levels, altering soil chemistries (Noble *et al.*, 1996, in Batcher, 2000). According to van Wilgen *et al.* (2001), it can also change the feeding dynamics of frugivorous birds. In its adventive range, *M. azedarach* has successfully invaded South African savannahs, the pampas of Argentina and relatively undisturbed floodplain hammocks, marshes and upland woods in Florida (Langeland and Burks, 1998; Hood and Naiman, 2000; Van Wilgen *et al.*, 2001; Ghersa *et al.*, 2002; Henderson, 2007). It has also been recorded as invasive in the Matopos, Hwange and Kyle National Parks in Zimbabwe. Natural regeneration of *M. azedarach* was observed in Zimbabwe in about 1956, roughly 55 years after its introduction (SRFC, 1956). *M. azedarach* flowers are a respiratory irritant, and the leaves, bark, flowers and fruits are toxic (Henderson, 2001), having led to recorded incidences of poisoning in pigs (Everist, 1974; Ottino and Renner, 1997), sheep, cattle and dogs. There have also been reports of poisonings in children who have eaten the fruit (Cremer, 1990).

Notes: Often grown as an ornamental in Malawi and Zambia it has occasionally escaped cultivation and was recorded as invasive at a few localities. According to Flora Zambesiaca, *M. azedarach* was recorded in Malawi on the Phalombe Plain in 1956. An herbarium specimen was collected in Malawi in 1965 on the roadside between Mangochi and Monkey Bay Districts with other specimens collected south of Dedza District, and between Likuni and Malingunde in Lilongwe District. Present in North-western, Luapula, Eastern and Lusaka Provinces in Zambia (Phiri, 2005) and regarded as invasive throughout Zimbabwe (Maroyi, 2012).



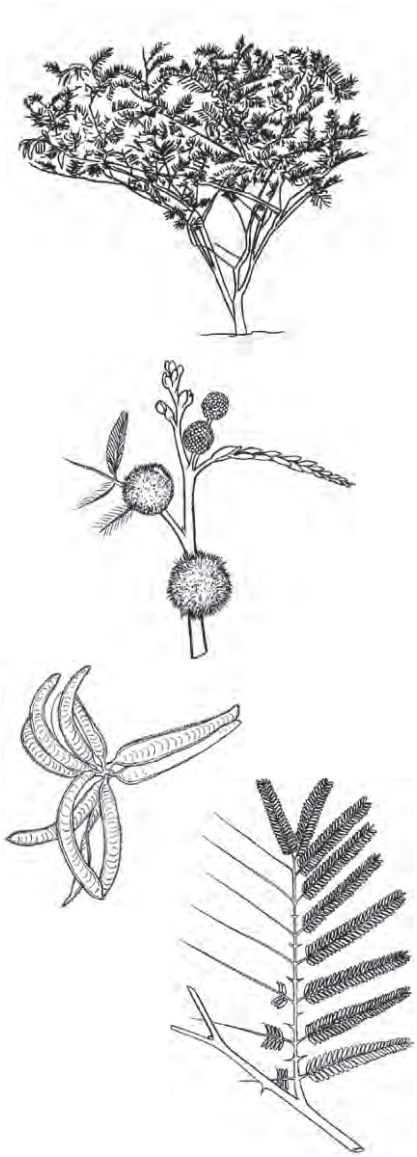






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Mimosa pigra L.



PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: bashful bush, black mimosa, giant mimosa, giant sensitive plant
Vernacular: kalikalula, lungwiziluzi, ngoza

DESCRIPTION
Evergreen shrub or small tree (3–6 m high), forming dense thickets; young stems green, rounded, armed with scattered prickles (5–12 mm long); taproot 1–2 m deep.

Bark: Older stems are grey and woody.

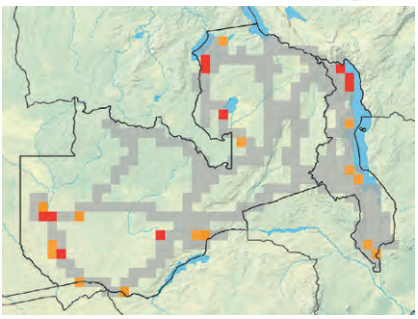
Leaves: Yellowish-green with short fine hairs below, twice-divided (20–31 cm long), straight thorn at the junction of each of 6–16 pairs of leaflet branchlets, each branchlet with 20–45 pairs of small elongated leaflets (3–12 mm long and 0.5–2 mm wide), leaves fold together at night or when touched.

Flowers: Pink or mauve, in fluffy round heads (1–2 cm wide), borne singly or in groups of two or three, on stalks (2–7 cm long) arising from each upper-leaf fork.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, flat and elongated (3–12 cm long and 7–14 mm wide), covered with bristly hairs, borne in clusters (of 1–30), break transversely into 14–26 segments; seeds greenish-brown to light brown (4–6 mm long and 2–2.5 mm wide).

ORIGIN
Argentina, Belize, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Honduras, Mexico, Nicaragua, Panama, Peru, Surinam and Venezuela.

REASON FOR INTRODUCTION
Green manure, nitrogen fixation, medicine, hedge/barrier and ornament.



INVADES
Roadsides, disturbed land, wastelands, urban open spaces, drainage ditches, irrigation channels, dams, riversides, floodplains, swamps, wetlands, lake edges and gullies.

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IMPACTS

Research has shown that dense infestations of *M. pigra* contribute to steep declines, both in the numbers of species of native plants and animals and in their population sizes. In the Tram Chim National Park, Vietnam, declining densities of native plant species in infested habitats are threatening the sarus crane (Triet and Dung, 2001), which is listed as vulnerable. *M. pigra* thickets in Australia have been found to support fewer birds and lizards, less herbaceous vegetation, and fewer tree seedlings than native vegetation (Braithwaite *et al.*, 1989). In Lochinvar National Park, Zambia, invasions have reduced bird diversity by almost 50% and bird abundance by more than 95% (Shanungu, 2009). According to respondents living along the Kafue River floodplains in Zambia, it has a negative impact on biodiversity, wildlife, livestock, crop production, fishing and mobility (Witt *et al.*, 2020b). Dense stands prevent the movement of people and livestock, limiting access to croplands, grazing lands and fishing areas (Witt *et al.*, 2020b). Fish catches have been reduced and fishing equipment damaged (Witt *et al.*, 2020b). In Cambodia, farmers have ranked mimosa as the most significant problem affecting rice farming, "ahead of rodents, other pests, and drought" (Chamroeun *et al.*, 2002). *M. pigra* also hampers fishing activities, and blocks access to water bodies.

Notes: Invasive in northern Malawi and parts of Zambia, especially in the Kafue River floodplain in Lochinvar National Park and the Barotse floodplain, both in Zambia. According to Phiri (2005) it is present in Luapula, Northern, Eastern, Lusaka, Southern, and Western Provinces in Zambia (Phiri, 2005). Also recorded in South Luangwa National Park, Zambia (Astle *et al.*, 1997). Herbarium specimens in Malawi were collected in 1933 in the Lower Shire Valley between Bangula and Chiromo followed by collections along the Kalonga River in Nkhata Bay in 1953; and at Chintheche in Nkhata Bay in 1970. Also reported as present in Malawi and Zambia by Drummond (1975).







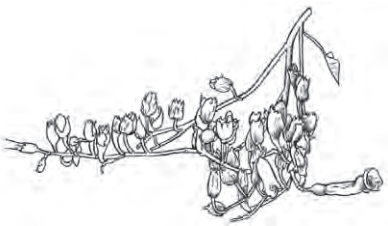


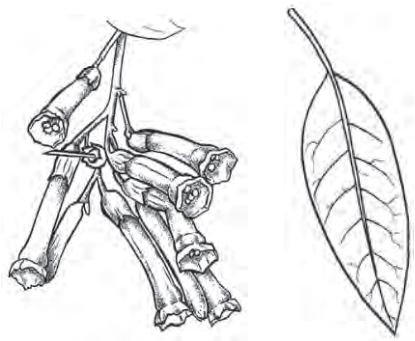


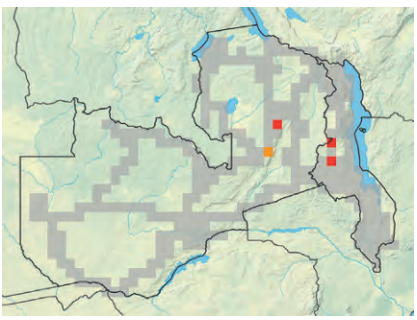
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Nicotiana glauca Graham









COMMON NAMES
English: mustard tree, tobacco bush, tree tobacco, wild tobacco

NIGHTSHADE FAMILY
Solanaceae

DESCRIPTION
Evergreen, hairless soft-wooded shrub or small tree (2–8 m tall); blue-green with purplish tints.

Leaves: Bluish or greyish-green, leathery and thick, sword-shaped or oval (5–25 cm long and 12 cm wide) with pointed tips, held alternately on stems on long stalks; leaves larger on young growth.

Flowers: Greenish-yellow, tubular (3–4 cm long), in terminal drooping clusters.

Fruits: Capsules (dry fruits that open at maturity), green turning brown-black as they mature, egg-shaped, with four chambers (15 mm long) containing tiny seeds.

REASON FOR INTRODUCTION
Medicine, insecticide and ornament.

ORIGIN
Argentina, Brazil, Bolivia, Chile, Ecuador, Paraguay, Peru and Uruguay.

INVADES
Roadsides, wasteland, disturbed land, drainage ditches, floodplains, riverbanks, riverbeds and dry water channels.



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IMPACTS

Grows rapidly, forming dense stands which displace native species. Leaf-litter and twig leachates inhibit the germination of native plant species (Florentine and Westbrooke, 2005). On Ascension Island, *N. glauca* may be displacing endemic species such as *Euphorbia origanoides* L. (Euphorbiaceae) (critically endangered) and *Anogramma ascensionis* (Hook.) Dielsby (Pteridaceae), dominating sites and altering ecological conditions (Gray *et al.*, 2005). *N. glauca* is highly toxic. Its ingestion has reportedly caused the deaths of farmed ostriches (Botha *et al.*, 2011). Toxic signs in sheep include "excess salivation, irregular gait, wobbling while walking or standing, recumbency and death" (Keeler and Crowe, 1984). Some people have died after eating the plant, having mistaken it for spinach or for another palatable vegetable (Hassen *et al.*, 2014). It is also an alternative host for vectors of solanaceous crop diseases (Aviña-Padilla *et al.*, 2008).

Notes: Probably more widespread in Malawi and Zambia than indicated. Found to be naturalized and/or invasive on roadsides and dry river beds in Malawi and Zambia where it has formed small stands. Widely naturalized in disturbed areas and along watercourses throughout Zimbabwe (Maroyi, 2012; Flora of Zimbabwe, 2020).





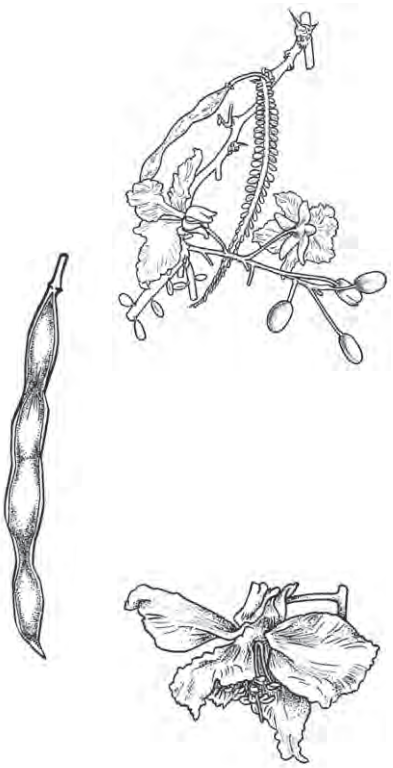




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Parkinsonia aculeata L.





PEA FAMILY
Fabaceae; sub-family: Caesalpinaceae

COMMON NAMES
English: horse bean, jelly bean tree, Jerusalem thorn, parkinsonian

DESCRIPTION
Evergreen tree [2–6 (–10) m high]; stem smooth, hairless, greenish-yellow when young turning brown, branches zigzagged, armed with stout spines (3–20 mm long) below each leaf.

Bark: Greenish-yellow turning brown, smooth.

Leaves: Light green, once-divided in young plants becoming twice-divided in older plants with 1 or 2 (–3) pairs of very long, slender, drooping, flattened branchlets (20–40 cm long) each with 20–30 pairs of very small egg-shaped to somewhat elongated leaflets with almost parallel sides [1–4 (–10) mm long and 1–2 mm wide].

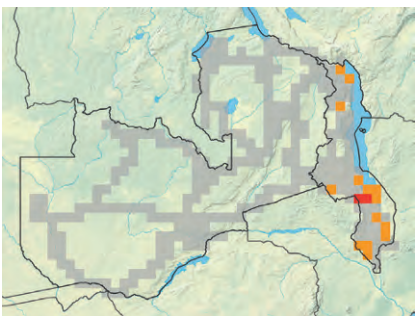
Flowers: Yellow and fragrant (2–3 cm across) with red or brown dots on the largest petal, in slender elongated clusters (5–20 cm long) arising from the leaf forks.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning brown as they mature, narrow, elongated (3–13 cm long and 5–10 mm wide), swollen around each of the large seeds (9–15 mm long and 3–6 mm wide).

REASON FOR INTRODUCTION
Hedge/barrier, shade and ornament.

ORIGIN
Argentina, Bolivia, Galapagos Islands, Paraguay, Peru and Uruguay.

INVADES
Roadsides, disturbed land, drainage ditches, edges of irrigation channels, riversides, lowlands, floodplains, gullies and water courses.



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IMPACTS

Forms large, impenetrable thickets, displacing native plant and animal species. According to Weber (2003), once it has become dominant it reduces species richness under stands. In Australia, this weed already occupies more than one million hectares, and has the potential to invade more than three-quarters of mainland Australia (Australian Weeds Committee, 2012). There, infestations have blocked or retarded water flows, increased erosion, lowered the water table, restricted access to land and to waterways, and blocked access by livestock to watering points. Dense stands of *P. aculeata* also harbour feral animals such as pigs – and contribute to additional mustering costs (Australian Weeds Committee, 2012). The livestock carrying capacities of pastures have been reduced. The spines on these trees/shrubs can cause injuries to people and to livestock and wild animals. In New Caledonia, *P. aculeata* has been described as one of the single biggest threats to productivity and profitability (Swarbrick, 1997).

Notes: Not recorded in Zambia during surveys although we suspect that it may be present there. Occasionally seen in Malawi where it was recorded as invasive at two localities. Previously collected, based on herbarium specimens, in Limbe, Blantyre District, in 1981. Known to be naturalized in parts of Zimbabwe (Flora of Zimbabwe, 2020), especially in the western region (Maroyi, 2012).

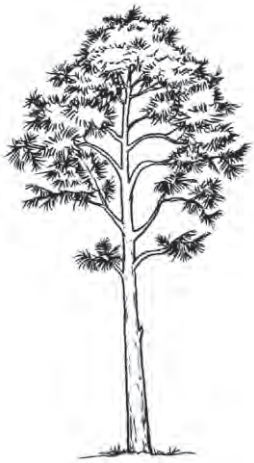


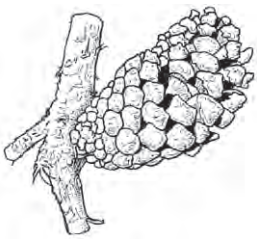


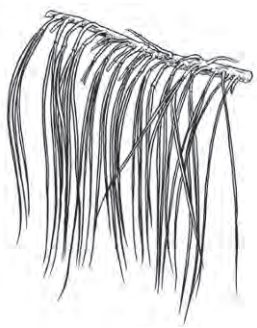




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PINE FAMILY
Pinaceae

COMMON NAMES
English: patula pine. Mexican pine, Mexican weeping pine, weeping pine
Vernacular: paini

DESCRIPTION
Large evergreen coniferous tree with drooping or 'weeping' foliage [12–20 (–40) m high]; straight cylindrical trunk (to 1.2 m in diameter), sometimes forked with two or more stems, conical when young but developing a dense, rounded canopy at maturity; often forking low down with branches almost horizontal and turning up at the ends.

Bark: Young bark reddish-orange and scaly, becoming grey to dark brown, vertically ridged.

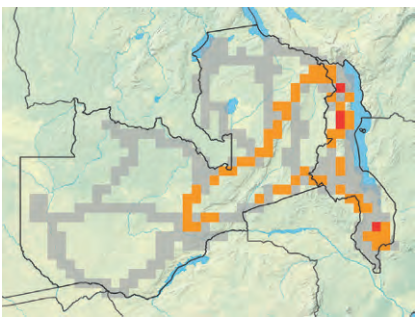
Leaves: Grey-green to yellow-green needles in bundles of 3, occasionally 4 and rarely 5, slender and drooping (15–25 cm long).

Cones: Pale brown or yellowish-brown, shiny, woody, conical (7–10 cm long), single or in clusters of 2–5, sometimes 8, bent backwards on short stalks; cone scales with sunken centres.

ORIGIN
Mexico.

REASON FOR INTRODUCTION
Timber, paper and pulp production.

INVADES
Roadsides, disturbed areas, grasslands and forest edges/ gaps.



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IMPACTS

P. patula has the ability to form dense stands, displacing native plant and animal species. In South Africa, *Pinus* species have invaded numerous conservation areas, displacing native plant species and reducing water run-off (Richardson and Higgins, 1998; van Wilgen and van Wyk, 1999). Species richness and diversity among invertebrates has been found to be lower in pine plantations (which are similar to dense pine infestations) than in indigenous vegetation (Samways *et al.*, 1996). In terms of water-use, pine plantations on the Drakensberg in KwaZulu-Natal, South Africa, have reduced stream flows by 82% (Bosch, 1979), while in the Western Cape stream-flows from invaded fynbos water catchments have declined by 55%. In South Africa's Mpumalanga Province, the replacement of grassland catchment areas with pines and eucalypts led, within 6–12 years, to the drying up of streams (van Lill *et al.*, 1980). There, removal of dense stands of pines and wattles from river banks has resulted in a 120% increase in stream-flows (Dye and Poulter, 1995). *P. patula* is also invasive in Hawaii (USA), Zimbabwe, Botswana and Malawi (Haysom and Murphy, 2003), as well as in both Madagascar and New Zealand (Richardson and Rejmánek, 2004). In Zimbabwe, *P. patula* is considered to be one of the most aggressive invaders of afromontane forests, grasslands and miombo woodlands in localities above 1,600 metres above sea level where it is able to produce viable seed. It can establish itself directly into undisturbed grassland and forest (Timberlake *et al.*, 1999).

Notes: Widespread, especially in Malawi, where it is grown around homes, in small woodlots and in large plantations. Has escaped from cultivation in Malawi, forming dense stands in grasslands and forest edges and gaps, especially in the higher-lying areas. Invasive in Nyika National Park and Mount Mulanje Forest Reserve. Been present in Malawi for some time with an herbarium specimen collected in 1965 in Limbe, Blantyre District. Now naturalized in many areas in Zimbabwe, and invasive along forest margins and in high rainfall woodlands (Flora of Zimbabwe, 2020) in the central and eastern regions (Maroyi, 2012).







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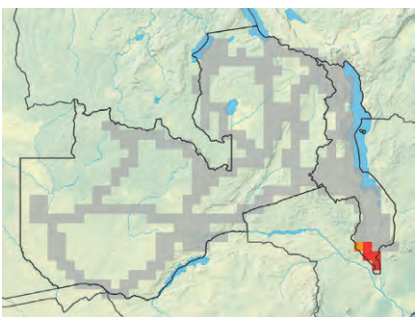
Prosopis juliflora (Sw.) DC.











PEA FAMILY
Fabaceae; sub-family: Mimosaceae

COMMON NAMES
English: algorroba, ironwood, mesquite

DESCRIPTION
Evergreen shrub or tree [3–5 (–15) m high] with thorns/spines; multi-stemmed but occasionally single-stemmed, twigs distinctively zigzagged.

Bark: Thick, rough grey-green, becoming scaly with age and armed with sharp thorns/spines (to 5 cm long).

Leaves: Dark green, hairless or hairy, twice-divided, 1–3 (–4) pairs of leaf branchlets (3–11 cm long), each with 11–15 pairs of leaflets, narrow, somewhat elongated with parallel sides (6–23 mm long and 1.6–5.5 mm wide), with smooth margins, no terminal leaflet, leaves grow alternately on the stems.

Flowers: Yellow, small, in cylindrical spikes (5–10 cm long and 1.5 cm side), solitary or in clusters near the leaf axils, fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning yellow as they mature, flat, slightly curved (8–29 cm long and 9–17 mm wide), containing 10–20 oval seeds (2–8 mm long).

ORIGIN
Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama and Venezuela.

REASON FOR INTRODUCTION
Fuelwood, timber, fodder, tannin, landscape restoration, windbreaks, shade, hedge/barrier and ornament.

INVADES
Roadsides, disturbed land, wastelands, fallow land, drainage ditches, woodland edges/gaps, savannahs, riparian vegetation, floodplains, gullies and sandy stream beds.



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IMPACTS

Displaces native plant species and reduces the abundance and diversity of birds and other animal species. In Ethiopia, *P. juliflora* has reduced understorey basal cover for perennial grasses from 68% to 2%, and has reduced the number of grass species from seven to two (Kebede and Coppock, 2015). By transforming habitats and eliminating pasture species, *P. juliflora* is threatening the survival of Grévy's zebra (*Equus grevyi*) in invaded areas (Kebede and Coppock, 2015). *P. juliflora* also has a dramatic negative impact on underground water resources. Other negative impacts include encroachment on to paths, villages, homes, crop- and pasturelands, and injuries inflicted by the thorns (Mwangi and Swallow, 2008; Maundu *et al.*, 2009). Infestations have contributed to the abandonment of agricultural land, and in some cases of homes and small villages as well. The pollen has been identified as a major allergen (Killian and McMichael, 2004). In semi-arid parts of Africa, *P. juliflora* has depleted the natural resources on which many thousands of people depend, spawning conflict between communities over the diminishing resources. In Phalombe, Malawi, invasive prosopis was considered to be a nuisance by everyone because its vicious spines caused injuries; dense stands prevented access/movement; invasions reduced grazing in the floodplain; and took up land previously used for maize and rice farming (Chikuni *et al.*, 2004). In invaded areas of north-eastern Brazil and the *Caatinga* biome, *P. juliflora* now reportedly accounts for around 87% of total ground cover, and has drastically altered the diversity and structure of native forests (Pegado *et al.*, 2006). In invaded riparian areas in Bahia, the species accounts for 60.8% of all plant species in regenerating forests (P.C.F. Lima and L.H.P. Kiill, *unpubl. data*, in Zenni and Ziller, 2011).

Notes: Not seen in Zambia, and most of Malawi, but widespread and abundant in southern Malawi. Also known to be present in Swang'oma, Phalombe, on the Lake Chilwa Plain (Chikuni *et al.*, 2004). According to Bunderson *et al.* (2002) the "foliage is unpalatable so it can become a weed if grazing and land-use pressures are low."







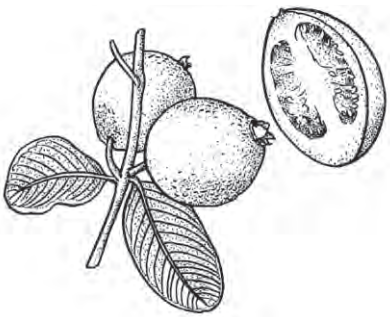


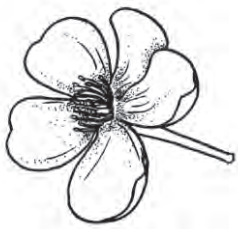


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Psidium guajava L.







MYRTLE FAMILY
Myrtaceae

COMMON NAMES
English: Brazilian guava, common guava, guava, yellow guava
Vernacular: guwawa, gwafa, gwawa, gwaba

DESCRIPTION
Evergreen tree or small shrub [1–6 (–10) m tall], stems smooth, young stems four-angled, green and hairy.

Bark: Reddish-brown, peels off in flakes giving the trunk a mottled appearance.

Leaves: Bronze turning light green, hairy undersides, egg-shaped, oval to elongated (7–15 cm long and 3–7 cm wide), often broad and rounded at both ends with a small, pointed tip, 10–20 pairs of very obvious veins on the underside, held opposite each other on the stems.

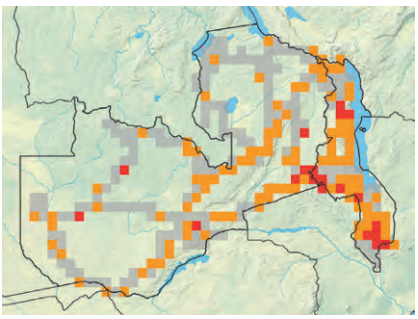
Flowers: White (about 25 mm across), held on hairy stalks (1–2.5 cm long) in groups of 1–3.

Fruits: Berries (fleshy fruits that open at maturity), green turning yellow as they mature, round to pear-shaped (2.5–10 cm long); flesh white, yellow or pink, with a strong odour.

ORIGIN
Argentina, Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Mexico, Paraguay, Peru, Surinam, Venezuela and the Caribbean.

REASON FOR INTRODUCTION
Edible fruit.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, forest, forest edges/gaps, woodland, woodland edges/gaps, savannah and riparian vegetation.





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IMPACTS

Establishes dense stands, displacing native plant and animal species. It is considered to be allelopathic (Smith, 1998), impacting negatively on seed germination and root growth in lettuce (*Lactuca sativa L.*) (Chapla and Campos, 2010). In Zimbabwe, *P. guajava* is invasive in lowland forest areas of the eastern highlands. On Costa Rica, *P. guajava* is a serious weed in pastures, where it is hard to eradicate and can lead to land degradation (Somarriba, 1995). On Hawaii it has formed dense thickets in native *Acacia* forests (Cronk and Fuller, 1995; Smith, 1998). It is also a weed in agricultural areas of Puerto Rico (CABI, 2016), and is considered to be invasive on Bermuda and in Brazil (Ziller and Rosa, 2001). It is invasive in secondary forests on abandoned pasture in the Upper Paraná River Floodplain (Campos and Dickinson, 2005), where understoreys dominated by *P. guajava* support fewer native plant species (Chapla *et al.*, 2008). The species also covers large areas in the Galápagos archipelago where, together with quinine (*Cinchona pubescens* Vahl; Rubiaceae), it has turned previously treeless shrublands into highland forests (Jäger *et al.*, 2007; Watson *et al.*, 2009). Invasions have resulted in 57–88% declines in endemic herb and grass species (Jager *et al.*, 2007). Invasive *P. guajava* stands provide an alternative host for introduced and native fruit fly species, so increasing damage to cultivated crops (Langeland and Burks, 1998).

Notes: Often grown as a food crop throughout Malawi and Zambia, it has escaped cultivation in many areas and become invasive. Grows very readily from seed, doing particularly well at some lakeshore stations, e.g., Kota Kota (Williamson, 1954). According to Flora Zambesiaca it was already naturalized near Limpasa in Nkhata Bay in 1966 and present at Soche Hill College in Blantyre District in 1970. Present in North-western and Lusaka provinces in Zambia (Phiri, 2005). Previously also recorded in Malawi and Zambia by Drummond (1975). Invasive in all regions of Zimbabwe (Maroyi, 2012).







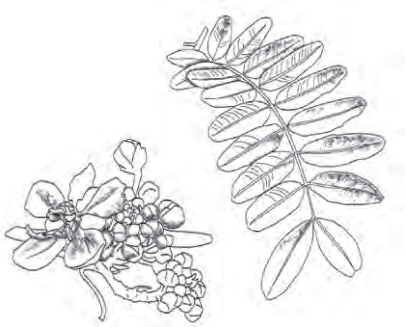


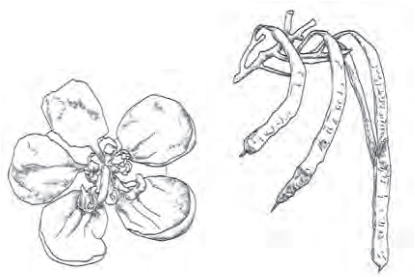


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Senna siamea (Lam.) H.S. Irwin & Barneby







PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: Bombay blackwood, cassia, iron wood, Thailand shower, Siamese senna, yellow cassia
Vernacular: kalisapwe (*Senna* spp.), maluwa, ndengere, kesha wa milimo

DESCRIPTION
Evergreen medium-sized tree (10–12 (–30) m tall) with a short, straight trunk (to 30 cm in diameter); crown dense and round at first becoming irregular and spreading with age; shallow root system.

Bark: Grey or light brown, smooth, becoming slightly fissured longitudinally with age.

Leaves: Dark green, once-divided [10–) 15–30 (–35) cm long] with 6–14 pairs of oblong leaflets (3–7 cm long and 12–20 mm wide), rounded at both ends with tiny bristled tips, leaves arranged alternately on stems.

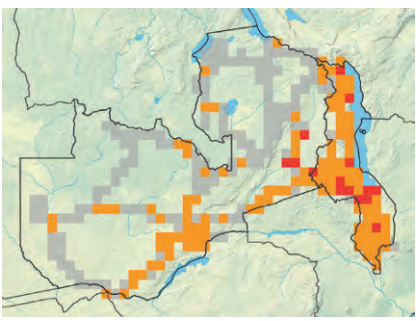
Flowers: Bright yellow (3 cm across), in upright, pyramidal-shaped clusters [20–30 (–60) cm long and 13 cm across] at the ends of the branches.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning dark brown as they mature, long, narrow, flat (15–25 cm long and 12–20 mm wide), constricted between seeds; seeds bean-shaped, shiny, dark brown (8 mm long).

ORIGIN
Brunei, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Thailand, Nepal, Philippines, Sri Lanka, Thailand and Vietnam.

REASON FOR INTRODUCTION
Ornament, shade, shelter, timber and fuelwood.

INVADES
Roadsides, disturbed areas, urban open spaces, plantations and open woodlands.





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IMPACTS

It has escaped cultivation in some areas, forming stands that may have a negative impact on native plant species. Contact with the wood shavings can irritate the skin. The leaves, pods and seeds are toxic to pigs and to poultry, and possibly to other species (CABI, 2016). The leaves are said to be poisonous to people.

Notes: Widely grown for ornament, or in woodlots for fuelwood, it has occasionally become naturalized in Malawi and Zambia. At some sites we considered it to be marginally invasive. According to Bunderson *et al.* (2002) it is "common as a shade and ornamental tree along roads, parks and gardens." An herbarium specimen was collected in 1967 at Mualivulezi Forest in Dedza District, Malawi. Present in Copperbelt, Northern, Central, Eastern, Lusaka, and Southern Provinces of Zambia (Phiri, 2005), and South Luangwa National Park (Astle *et al.*, 1997). In Zimbabwe it is grown as an ornamental tree and has escaped cultivation in the west (Flora of Zimbabwe, 2020). In Mozambique, it is naturalized around Chitengo Camp in Gorongosa National Park (Flora of Mozambique, 2020).





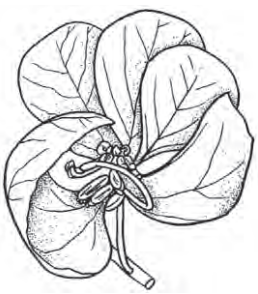


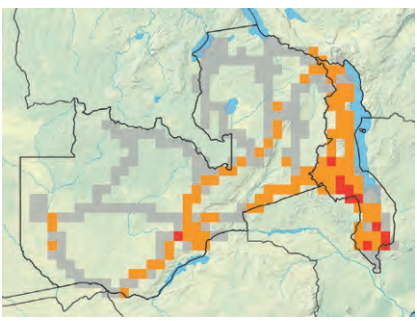


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PEA FAMILY
Fabaceae; sub-family: Caesalpiniaceae

COMMON NAMES
English: calceolaria shower, cassia, pisabed, yellow shower
Vernacular: kalisapwe (*Senna* spp.), kesha wa maluwa

DESCRIPTION
Tree [7–10 (–15) m tall] with a spreading crown, deciduous (sheds most or all of its leaves at the end of the growing season), trunk to 30 cm in diameter.

Bark: Smooth, grey, with horizontal markings, of warts and short fissures, becoming rougher with age, with broad vertical bands of large lenticels.

Leaves: Green, usually softly hairy below, once-divided (to 40 cm long) with 4–15 (–19) pairs of leaflets, narrowly oval (to 7.5 cm long), tapering towards the tips.

Flowers: Yellow, held in large, branched erect terminal clusters [15–30 (–90) cm long], fragrant.

Fruits: Pods (several-seeded dry fruits that split open at maturity), green turning black as they mature, cylindrical or flattened (18–25 cm long), ending in a short, narrow point, hard, not splitting open or splitting only slightly on one side, with many cross walls (to 3 mm apart) between separate seed compartments; seeds 50–70, flattened, brown (about 5 mm wide).

ORIGIN
Antigua and Barbuda, Argentina, Bahamas, Barbados, Bolivia, Brazil, Chile, Colombia, Cuba, Dominica, Dominican Republic, Ecuador, French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Netherlands Antilles, Nicaragua, Panama, Paraguay, Peru, St Kitts and Nevis, St Lucia, St Vincent and the Grenadines, Surinam, Trinidad and Tobago, Uruguay and Venezuela.

REASON FOR INTRODUCTION
Fuelwood, boundary markers and ornament.

INVADES
Roadsides, disturbed areas, wastelands, urban open space, plantations, forest edges/gaps, woodlands, woodland edges/gaps and riparian vegetation.



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IMPACTS

S. spectabilis grows rapidly, dominating other species in the wild and displacing native flora, and in cultivated lands out-competing crops, causing reduced crop yields (Noordwijk *et al.*, 2004). Stands in the Mahale Mountains National Park, western Tanzania, now cover an estimated 225 ha. There, in areas where the species has been removed or killed, the abundance of native tree species has increased markedly. According to Wakibara and Mnaya (2002), *S. spectabilis* appears to have suppressed renewal among native trees in the Park, and its removal alone has been enough to encourage regeneration of degraded forest, without the need for artificial re-seeding. In India, infestations of *S. spectabilis* and of other invasive plant species [including *Lantana camara* L. (Verbenaceae), *Chromolaena odorata* (L.) R.M. King & H. Rob. (Asteraceae) and *Parthenium hysterophorus* L. (Asteraceae)] are posing a threat to wildlife and indigenous plants in the forest areas of the Nilgiri Biosphere Reserve, including the Wayanad Wildlife Sanctuary, a major habitat for the country's Asiatic elephants. Areas in this part of India invaded by *S. spectabilis* cover nearly 3,000 km^2, in the North and South Wayanad Forest Divisions and in the adjacent Muthumalai, Bandipur and Nagarhole Tiger Reserves, as well as in the Wayanad Wildlife Sanctuary. The resulting displacement of valuable forage plants may exacerbate "man-animal conflict" (Manoj, *The Hindu*, 2014; Rajeev, *The Times of India*, 2015).

Notes: Promoted as an agro-forestry species throughout most of Malawi and Zambia. Recorded as naturalized in many areas in Malawi, and occasionally marginally invasive, it was never recorded in large and dense stands. The first herbarium specimen was collected in 1974 at the arboretum at Chongoni in Dedza District. **"**Popular as a shade and ornamental tree along roads, parks and gardens" (Bunderson *et al.*, 2002). Recorded as a casual alien in the west of Zimbabwe (Maroyi, 2012).

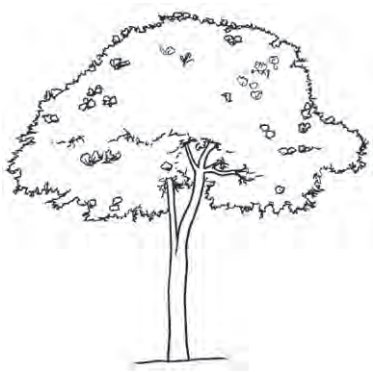




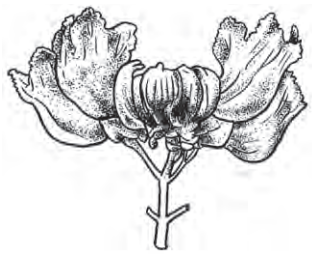




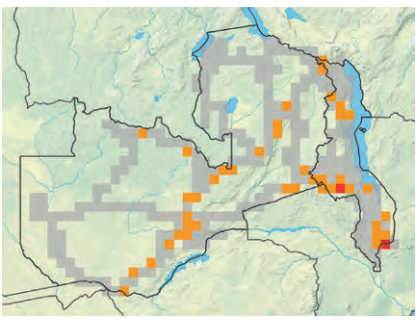
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JACARANDA FAMILY
Bignoniaceae

COMMON NAMES
English: fireball; Flame tree; fountain tree; Nandi flame; Nile flame; tulip tree

DESCRIPTION
Deciduous, large, upright tree [10–15 (–35) m tall] and trunk up to 170 cm in diameter with a dense wide crown; younger branches are almost hairless or having a sparse covering of short hairs, older branches thick with small white-coloured corky spots; shoots, buds and branchlets covered in yellow-brown hairs, slightly buttressed.

Bark: Pale, grey-brown, smooth, rough with age.

Leaves: Green, yellow-brown soft hairs on underside, large compound leaves (50 cm long) with (7–) 11–15 (–17) leaflets, broadly oval or egg-shaped (15 cm long and 7.5 cm wide), margins entire, 2–3 glands at base of each leaflet, leaves oppositely arranged on stalks up to 6 cm long.

Flowers: Orange, showy, tulip-shaped, dense clusters (8–10 cm long) at ends of branches; cluster stalk (10 cm long), individual flower stalks short and covered in brownish hairs (yellow-flowering variety exists).

Fruit: Pods (several-seeded dry fruits that split open at maturity), green changing to brown as they mature, elongated (17–30 cm long and 3.5–5 cm wide).

ORIGIN
Angola, Benin, Burundi, Cameroon, DRC, Equatorial Guinea, Gabon, Ghana, Guinea, Ivory Coast, Liberia, Nigeria, Rwanda, Sierra Leone, and Togo.

INTRODUCED FOR
Fuelwood, carving, medicine, bee forage, shade, ornamental, mulch, windbreak, and erosion control.

INVADES
Roadsides, disturbed land, forest edges/gaps and riparian areas.



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IMPACTS

Native plants are displaced by the shading effect of the large leaves, resulting in reduced biodiversity under tree canopies (Weber, 2003). In surveys in Fiji respondents claimed that the African tulip tree competes with crops, reduces the amount of land available for grazing livestock and that it leads to the loss of more desirable trees that are used for medicinal purposes and/or firewood (Brown and Daigneault, 2014). It is a weed of coffee plantations in Cuba (Herrera-Isla *et al.*, 2002) reducing yields.

Notes: Widely planted as an ornamental but rarely naturalized. Found to be locally abundant on the outskirts of Mulanje Town, Malawi. According to herbarium records the first specimen was collected in 1966 at the Silvicultural Arboretum Garden in Dedza District and Shire Highlands Hotel, Limbe, Blantyre. Reported as a casual alien in the eastern region of Zimbabwe (Maroyi, 2012).









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Tecoma stans (L.) Juss ex Kunth







JACARANDA FAMILY
Bignoniaceae

COMMON NAMES
English: tecoma, trumpet flower, yellow bells, yellow elder, yellow trumpet flower

DESCRIPTION
Large shrub or small tree [1.5–5 (–10) m tall], much-branched; younger stems greenish, smooth, hairless, four-angled.

Bark: Light brown to pale grey, furrowed and rough in texture.

Leaves: Green, generally hairless, soft to the touch, once-divided (10–25 cm long) with 3–7 (–13) egg-shaped or elongated leaflets (25–100 mm long and 8–30 mm wide), terminal leaflet larger, margins sharply toothed with pointed tips; leaves on slender stalks (1–9 cm long).

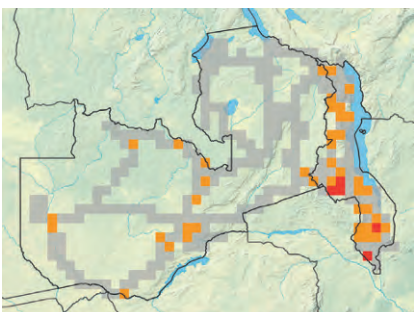
Flowers: Bright yellow, tubular or trumpet-shaped (50 mm long) with 5 rounded lobes, on short stalks in several-flowered clusters (5–15 cm long), showy.

Fruits: Capsules (dry fruits that split open at maturity), green turning brown as they mature, large, elongated and somewhat flattened (10–30 cm long and 5–20 mm wide), splitting open to release many papery seeds; the split capsules remain on the trees for months, in untidy clusters.

ORIGIN
Mexico, Ecuador, Peru, USA and the Caribbean.

REASON FOR INTRODUCTION
Ornament.

INVADES
Roadsides, waterways, riparian vegetation, open woodlands, grasslands, forest margins, waste areas and disturbed sites in tropical and sub-tropical environments.





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IMPACTS

Forms dense stands which may result in the displacement of native species. It forms dense monospecific thickets that restrict the regeneration of native species (ISSG, 2015). Introduced into Brazil, it now occupies more than 10,000 ha of degraded Alto Paraná Atlantic Forests (Bredow *et al.*, 2004). Infestations there have also led to the abandonment of productive land, including pastures. Losses to the cattle industry alone reportedly amount to some US$ 7.5-million annually (Pedrosa-Macedo, 2004). In south Florida in invades dry disturbed sites, pine rocklands, and rockland hammocks. In South Africa it invades savannah, watercourses, rocky sites, urban open spaces, roadsides, railway lines, and wastelands (Henderson, 2020).

Notes: Often grown as an ornamental in Malawi and Zambia it has become naturalized and even locally abundant at some sites, especially in Malawi where it was recorded as invasive, mainly along roadsides and in urban open spaces. Herbarium records show that the first specimen was collected in 1968 at the Silvicultural Arboretum in Dedza District, Malawi. “Semi-naturalized” in Zimbabwe (Flora of Zimbabwe, 2020) where it is considered to be a casual alien in the central region (Maroyi, 2020).





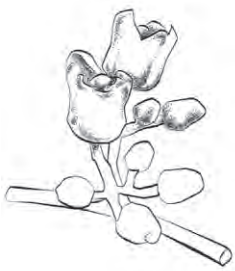


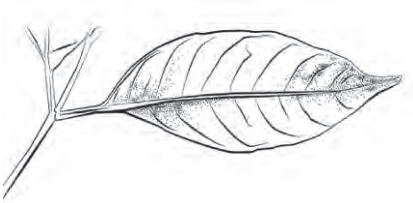


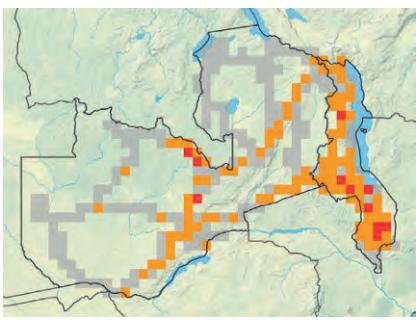
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Toona ciliata M. Roem.









MAHOGANY FAMILY
Meliaceae

COMMON NAMES
English: Australian red cedar, Burma cedar, Indian cedar, Indian mahogany, Queensland red cedar, red cedar
Vernacular: cederela, mulemwa, sindirela

DESCRIPTION
Large tree [20–30 (–55) m tall], deciduous (sheds most or all of its leaves at the end of the growing season); trunk thick (1.8–3 m in diameter) with buttresses; crown spreading/rounded.

Bark: Dark grey or reddish-brown, initially smooth and later rough, with shallow reticulate cracks exfoliating in irregular woody scales.

Leaves: Green, once-divided [30–50 (–90) cm long], with (9–) 11–17 (–29) sword- or egg-shaped leaflets (5–15 cm long and 2–6 cm wide), tapering to a sharp point with oblique bases, margins entire or wavy, hairy or sparsely hairy, leaflets opposite or alternate; leaf stalks variable (0.3–1.3 cm long).

Flowers: Greenish-white to yellowish or creamy, small (5 mm long), in drooping or sub-erect densely-branched terminal panicles or clusters (25–35 cm long), sweetly scented; in *Cedrela odorata* L. the terminal panicles are much larger (to 90 cm long) and have an unpleasant odour.

Fruits: Capsules (dry fruits that open at maturity), green turning dark brown as they mature, elongated, smooth (1.8–2.5 cm long and 0.5–0.8 cm wide), with five chambers; seeds pale brown, winged (1.3–1.5 cm long including the wing).

ORIGIN
Bangladesh, Cambodia, China, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, Thailand and Vietnam.

REASON FOR INTRODUCTION
Fuelwood, timber, tannin and ornament.

INVADES
Roadsides, disturbed areas, forest edges/gaps and riparian vegetation.



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IMPACTS

Has the ability to form dense stands, displacing native plants and preventing their regeneration. It is considered to be "very aggressive and invasive, and unsuitable for planting in gardens or near food crops because of its shallow and aggressive root system" (Katende *et al.*, 1995). A fast-growing, light-demanding pioneer species, it spreads rapidly in disturbed forests and cleared areas. In South Africa, it has out-competed indigenous species, particularly in forested areas and along river banks (ISSA, 2012). Its spreading, superficial root system may have adverse effects on the growth of agricultural crops.

Notes: A very popular tree that has been widely planted in Malawi and Zambia. It is occasionally naturalized and even invasive at some localities in both countries, establishing stands on roadsides and forest edges. According to Williamson (1954), it was widely planted as an avenue tree and sometimes used in afforestation. An herbarium specimen was collected in 1962 in Bunda Hill Forest in Lilongwe District followed by collections in 1969 and 1970 in Blantyre District. In Zambia, it is present in six of the nine provinces (Copperbelt, Northern, Central, Eastern, Lusaka, Southern) (Phiri, 2005). Also reported as present in Malawi and Zambia by Drummond (1975). In Zimbabwe, it is "commonly cultivated in gardens and as a street tree and frequently escaping into wild areas" (Flora of Zimbabwe, 2020). According to Maroyi (2012) it is invasive in all regions of Zimbabwe.









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Images of naturalized species of plants for which there are no detailed factsheets



Azadirachta indica



Bauhinia purpurea



Brugmansia suaveolens



Bryophyllum daigremontianum



Bryophyllum delagoense



Cosmos bipinnatus



Cosmos sulphureus

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Ipomoea nil



Ipomoea indica



Ipomoea purpurea



Ipomoea alba



Physalis peruviana



Pontederia cordata



Thunbergia grandiflora

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Useful Websites

African Convention on the Conservation of Nature and Natural Resources (**www.au.int**)

Alien Invasive Plants List for South Africa (**www.environment.co.za/weeds-invaders-alien-vegetation/alien-invasive-plants-list-for-south-africa.html**)

BioNET-EAFRINET keys and factsheet website for invasive plants (**http://keys.lucidcentral.org/keys/v3/eafrinet/plants.htm**)

CABI Invasive Species Compendium (ISC) (**https://www.cabidigitallibrary.org/product/qi**)

Convention on Biological Diversity (CBD) (**www.cbd.int**)

Convention on Wetlands of International Importance (RAMSAR) (**www.ramsar.org**)

Environmental Weeds of Australia (**https://keyserver.lucidcentral.org/weeds/data/media/Html/fshelp.htm**)

Forest Invasive Species Network for Africa (FISNA) (**www.fao.org/forestry/fisna/en**)

Global Invasive Species Database (GISD) (**https://www.iucngisd.org/gisd/**)

International Plant Protection Convention (IPPC) (**www.ippc.int**)

Invasive Species South Africa (**www.invasives.org.za**)

New Partnership for Africa's Development (NEPAD) (**www.nepad.org**)

New South Wales Department of Primary Industries – NSW WeedWise (**https://weeds.dpi.nsw.gov.au**)

Pacific Island Ecosystems at Risk (PIER) (**www.hear.org/pier**)

Phytosanitary Convention for Africa (**www.au.int**)

Scientific Committee on Problems of the Environment (SCOPE) (**https://scope-environment.org/**)

World Agroforestry Centre (**www.agroforestry.org**)

United States Department of Agriculture (USDA) National Invasive Species Information Center (**www.invasivespeciesinfo.gov**)

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Appendix A

Summary table of naturalized and invasive plant species in Malawi and Zambia.

Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Hypoestes phyllostachya Baker	Acanthaceae	Herb/shrub	Ornament	Madagascar - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Thunbergia grandiflora Roxb.	Acanthaceae	Climber	Ornament	Asia - tropical	Witt, *pers. obs.*	
Agave americana L.	Agavaceae	Succulent tree/ shrub	Agricultural crop (fibre), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Agave angustifolia Haw.	Agavaceae	Succulent tree/ shrub	Agricultural crop (fibre), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Agave sisalana Perrine	Agavaceae	Succulent tree/ shrub	Agricultural crop (fibre), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Furcraea foetida (L.) Haw.	Agavaceae	Succulent tree/ shrub	Agricultural crop (fibre), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Alternanthera brasiliana (L.) Kuntze	Amaranthaceae	Herb	Medicinal, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Calotropis procera (Aiton) Dryand.*	Apocynaceae	Woody tree/ shrub	Barrier, medicinal, ornament	Africa - tropical	Williamson (1954); Witt, *pers. obs*	Witt, *pers. obs.*
Cascabela thevetia (L.) Lippold (Syn.: *Thevetia peruviana* (Pers.) K. Schum.	Apocynaceae	Woody tree/ shrub	Barrier, medicinal, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Catharanthus roseus (L.) G. Don	Apocynaceae	Herb or sub-shrub	Medicinal, ornament	Madagascar - tropical	Flora of Malawi (2020); Witt, *pers. obs.*	Witt, *pers. obs.*
Pistia stratiotes L.	Araceae	Aquatic	Ornament	?America – tropical (see narrative for additional information on possible origin)	Blackmore *et al.* (1998); Williamson (1954); Witt, *pers. obs.*	Blackmore *et al.* (1998); Williamson (1954); Witt, *pers. obs.*
Acmella radicans (Jacq.) R.K. Jansen	Asteraceae	Herb	Medicinal	America - tropical	Flora of Zambia (2020); Witt, *pers. obs.*	Flora of Zambia (2020); Witt, *pers. obs.*
Ageratum conyzoides L.	Asteraceae	Herb	Ornament	America - tropical	Flora of Malawi (2020); Flora of Zambia (2020); Witt, *pers. obs.*	Flora of Malawi (2020); Flora of Zambia (2020); Witt, *pers. obs.*
Ageratum houstonianum Mill.	Asteraceae	Herb	Ornament	America - tropical	Flora of Zambia (2020); Witt, *pers. obs.*	Flora of Zambia (2020); Witt, *pers. obs.*
Cosmos bipinnatus Cav.	Asteraceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Cosmos sulphureus Cav.	Asteraceae	Herb	Ornament	America - tropical	CABI (2020); Witt, *pers. obs.*	CABI (2020); Witt, *pers. obs.*
Dahlia imperialis Roezl ex Ortgies	Asteraceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	
Erigeron karvinskianus DC. (unresolved)	Asteraceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Sphagneticola trilobata (L.) Pruski	Asteraceae	Herb	Cover/binder, ornament	America - tropical	Flora of Malawi (2020); Witt, *pers. obs.*	Witt, *pers. obs.*
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Woody tree/ shrub	Agricultural crop (green manure), barrier, ornament	America - tropical	Witt *et al.*, 2019; Witt, *pers. obs.*	Witt *et al.*, 2019; Witt, *pers. obs.*
Tithonia rotundifolia (Mill.) S.F. Blake	Asteraceae	Woody tree/ shrub	Agricultural crop (bee forage), barrier, ornament	America – tropical	Pickering and Roe (2009); Wild (1968); Witt *et al.*, 2019; Witt, *pers. obs.*	Wild (1968); Witt *et al.*, 2019; Witt, *pers. obs.*
Tithonia tubaeformis (Jacq.) Cass	Asteraceae	Woody tree/ shrub	Agricultural crop (bee forage), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Xanthium strumarium L.	Asteraceae	Herb	Medicinal	America – tropical	Wild (1968); Witt, *pers. obs.*	Wild (1968); Witt, *pers. obs.*
Zinnia elegans L.	Asteraceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Azolla filiculoides Lam.	Azollaceae	Aquatic	Ornament	America - tropical	Flora of Zambia (2020); Witt, *pers. obs.*	Witt, *pers. obs.*
Anredera cordifolia (Ten.) Steenis.	Basellaceae	Climber	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Climber	Ornament	America - tropical	?Witt, *pers. obs.*	
Jacaranda mimosifolia D. Don	Bignoniaceae	Woody tree/ shrub	Agricultural crop (bee forage), barrier, domestic, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Spathodea campanulata P. Beauv	Bignoniaceae	Woody tree/ shrub	Ornament	Africa - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Tecoma stans (L.) Juss. ex Kunth	Bignoniaceae	Woody tree/ shrub	Barrier, ornament	America -tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
?*Harrisia bonplandii* (Parm.) Britton & Rose or ?*Acanthocereus tetragonus* (L.) Hummelinck	Cactaceae	Succulent tree/ shrub	Barrier, ornament	America - tropical	Witt, *pers. obs.*	
Opuntia ficus-indica (L.) Mill.	Cactaceae	Succulent tree/ shrub	Agricultural crop (fodder, food), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia monacantha (Willd.) Haw.	Cactaceae	Succulent tree/ shrub	Agricultural crop (food), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Opuntia stricta (Haw.) Haw.	Cactaceae	Succulent tree/ shrub	Barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Canna × *generalis* L.H. Bailey & E.Z. Bailey	Cannaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Canna indica L.	Cannaceae	Herb	Ornament	America - tropical	Flora Zambesiaca; Shah and Makhambera (2019); Witt, *pers. obs.*	Shah and Makhambera (2019); Witt, *pers. obs.*

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Lonicera japonica Thunb.	Caprifoliaceae	Climber	Barrier, ornament	Asia - nth temperate	Witt, *pers. obs.*	
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Tradescantia zebrina Bosse	Commelinaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea alba L.	Convolvulaceae	Climber	Ornament	America - tropical	?Witt, *pers. obs.*	
Ipomoea carnea Jacq. subsp. *fistulosa* (Mart. ex Choisy)	Convolvulaceae	Woody tree/ shrub	Barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea hederifolia L.	Convolvulaceae	Climber	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ipomoea indica (Burm.) Merr.	Convolvulaceae	Climber	Ornament	America - tropical	Witt, *pers. obs.*	
Ipomoea nil (L.) Roth	Convolvulaceae	Climber	Ornament	America - tropical	?Witt, *pers. obs.*	
Ipomoea purpurea (L.) Roth	Convolvulaceae	Climber	Ornament	America - tropical	Witt, *pers. obs.*	
Ipomoea tricolor Cav.	Convolvulaceae	Climber	Ornament	America - tropical	Flora Zambesiaca; Pickering and Roe (2009); Witt, *pers. obs.*	Witt, *pers. obs.*
Stictocardia beraviensis (Vatke) Hall.*	Convolvulaceae	Climber	Medicinal, ornament	Africa - tropical	Witt, *pers. obs.*	
Bryophyllum daigremontianum Raym.-Hamet & H. Perrier) A. Berger	Crassulaceae	Succulent herb	Ornament	Madagascar - sth temperate	Witt, *pers. obs.*	
Bryophyllum delagoense (Eckl. & Zeyh.) Druce	Crassulaceae	Succulent herb	Medicinal, ornament	Madagascar - sth temperate	Witt, *pers. obs.*	
Bryophyllum pinnatum (Lam.) Oken	Crassulaceae	Succulent herb	Ornament	Madagascar - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Bryophyllum proliferum Bowie ex Hook.	Crassulaceae	Succulent herb	Ornament	Madagascar - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Luffa cylindrica (L.) N. Roem.	Cucurbitaceae	Vine	Agricultural crop (food), domestic	Asia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Pteridium aquilinum (L.) Kuhn	Dennstaedtiaceae	Fern	**Native**	Global	**Native**	**Native**
Jatropha curcas L.	Euphorbiaceae	Woody tree/ shrub	Agricultural crop (oil), barrier, medicinal, ornament	America - tropical	?Witt, *pers. obs.*	
Jatropha gossypiifolia L.	Euphorbiaceae	Woody tree/ shrub	Agricultural crop (oil), barrier, medicinal, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Ricinus communis L.*	Euphorbiaceae	Woody tree/ shrub	Agricultural crop (oil), medicinal, ornament	?Africa - tropical	CABI (2016); Williamson (1954); Witt, *pers. obs.*	CABI (2016); Williamson (1954); Witt, *pers. obs.*
?*Acacia dealbata* Link	Fabaceae	Woody tree/ shrub	Agricultural crop (bee forage, tannins), barrier, domestic, ornament, silvicultural crop	Australia - sth temperate	?Witt, *pers. obs.*	

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Acacia mearnsii De Wild	Fabaceae	Woody tree/ shrub	Agricultural crop (bee forage, tannins), barrier, domestic, ornament, silvicultural crop	Australia - sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Acacia melanoxylon R. Br	Fabaceae	Woody tree/ shrub	Barrier, domestic, ornament, silvicultural crop	Australia - sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Acaciella angustissima (Mill.) Brit. & Rose	Fabaceae	Woody tree/ shrub	Agricultural crop (nitrogen fixation), domestic, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Albizia chinensis (Osbeck) Merr.	Fabaceae	Woody tree/ shrub	Agricultural crop (fodder, nirogen fixation), domestic, ornament	Asia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Albizia lebbeck (L.) Benth	Fabaceae	Woody tree/ shrub	Agricultural crop (fodder, green manure), domestic, ornament	Asia – tropical	?Witt, *pers. obs.*	
Bauhinia purpurea L.	Fabaceae	Woody tree/ shrub	Domestic, ornament	Asia - tropical	?Witt, *pers. obs.*	
Bauhinia variegata L.	Fabaceae	Woody tree/ shrub	Domestic, ornament	Asia - tropical	Flora of Zambia (2020); Witt, *pers. obs.*	Flora of Zambia (2020); Witt, *pers. obs.*
Caesalpinia decapetala (Roth) Alston	Fabaceae	Climber	Agricultural crop (bee forage), barrier, ornament	Asia - tropical	Williamson (1954); Witt, *pers. obs.*	Williamson (1954); Witt, *pers. obs.*
Delonix regia (Hook.) Raf.	Fabaceae	Woody tree/ shrub	Ornament	Madagascar - tropical	Witt, *pers. obs.*	?Witt, *pers. obs.*
Desmodium intortum (Mill.) Urb.	Fabaceae	Herb or climber	Agricultural crop (fodder, nitrogen-fixation), cover/ binder	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Desmodium uncinatum (Jacq.) DC.	Fabaceae	Herb or climber	Agricultural crop (fodder, nitrogen-fixation), cover/ binder	America - tropical	Flora of Zambia (2020); Witt, *pers. obs.*	Flora of Zambia (2020); Witt, *pers. obs.*
Gliricidea sepium (Jacq.) Walp.	Fabaceae	Woody tree/ shrub	Agricultural crop (nitrogen-fixation, support for vanilla), domestic, ornament	America - tropical	Witt, *pers. obs.*	?Witt, *pers. obs.*
Guilandina bonduc L. (Syn: *Caesalpinia bonduc* (L.) Roxb.)*	Fabaceae	Climber	Agricultural crop (bee forage), barrier, medicinal, ornament	Africa - tropical	Witt, *pers. obs.*	
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Woody tree/ shrub	Agricultural crop (fodder, nitrogen-fixation), barrier, cover/binder, domestic, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Mimosa diplotricha Sauvalle	Fabaceae	Woody tree/ shrub	Barrier, cover/ binder, ornament	America - tropical	Witt *et al.* (2020a); Witt, *pers. obs.*	Witt *et al.* (2020a); Witt, *pers. obs.*

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Mimosa pigra L.	Fabaceae	Woody tree/ shrub	Agricultural crop (green manure, nitrogen-fixation), barrier, ornament	America - tropical	Shanungu (2009); Witt *et al.* (2020b); Witt, *pers. obs.*	Shanungu (2009); Witt *et al.* (2020b); Witt, *pers. obs.*
Mimosa pudica L.	Fabaceae	Herb	Cover/binder, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Parkinsonia aculeata L.	Fabaceae	Woody tree/ shrub	Agricultural crop (bee forage, fodder), barrier, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Prosopis juliflora (Sw.) DC.	Fabaceae	Woody tree/ shrub	Agricultural crop (bee forage, food, fodder), barrier, cover/binder, domestic, ornament	America - tropical	Chikuni *et al.* (2004); Witt, *pers. obs.*	Chikuni *et al.* (2004); Witt, *pers. obs.*
Senna alata (L.) Roxb.	Fabaceae	Woody tree/ shrub	Ornament, medicinal	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby*	Fabaceae	Woody tree/ shrub	Barrier, medicinal, ornament	Africa - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna hirsuta H.S. Irwin & Barneby	Fabaceae	Woody tree/ shrub	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna obtusifolia (L.) H.S. Irwin & Barneby	Fabaceae	Woody tree/ shrub	Medicine, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna occidentalis (L.) Link	Fabaceae	Woody tree/ shrub	Domestic, medicinal, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna septemtrionalis (Viv.) H.S. Irwin & Barneby	Fabaceae	Woody tree/ shrub	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Senna siamea (Lam.) H.S. Irwin & Barneby	Fabaceae	Woody tree/ shrub	Domestic, ornament	Asia - tropical	Witt, *pers. obs.*	?Witt, *pers. obs.*
Senna spectabilis (DC.) H.S. Irwin & Barneby	Fabaceae	Woody tree/ shrub	Barrier, domestic, ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Tephrosia vogelli Hook. f.*	Fabaceae	Woody tree/ shrub	Agricultural crop (nitrogen-fixation), domestic, medicine	?Africa - tropical	Witt, *pers. obs.*	?Witt, *pers. obs.*
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Aquatic	Ornament	America - tropical	CABI (2020); Flora Zambesiaca	CABI (2020); Flora Zambesiaca
Limnobium laevigatum (Humb. & Bonpl. ex Willd.) Heine	Hydrocharitaceae	Aquatic	Ornament	America - tropical	Howard *et al.* (2016); Weyl, *pers. obs.*	Howard *et al.* (2016); Weyl, *pers. obs.*
Gmelina arborea Roxb.	Lamiaceae	Woody tree/ shrub	Domestic	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Holmskioldia sanguinea Retz.	Lamiaceae	Woody tree/ shrub	Ornament	America - tropical	CABI (2020); Witt, *pers. obs.*	
Hyptis suaveolens (L.) Poit.	Lamiaceae	Herb	None	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Salvia coccinea Buc'hoz ex Etl.	Lamiaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Abutilon pictum (Gillies ex Hook.) Walp.	Malvaceae	Herb	Agricultural crop (food), ornament	America - temperate	Witt, *pers. obs.*	Witt, *pers. obs.*

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Urena lobata L.	Malvaceae	Herb		Asia - tropical	Astle *et al.* (1997); Smith (1998); Williamson (1954); Witt, *pers. obs.*	Williamson (1954); Witt, *pers. obs.*
Azadirachta indica A. Juss.	Meliaceae	Woody tree/ shrub	Agricultural crop (bee forage, insecticide), barrier, domestic, medicine, ornament	Asia - nth temperate	?Witt, *pers. obs.*	
Melia azedarach L.	Meliaceae	Woody tree/ shrub	Agricultural crop (bee forage, medicine), domestic, ornament	Australasia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Toona ciliata M. Roem.	Meliaceae	Woody tree/ shrub	Barrier, domestic, medicinal, ornament, silvicultural crop	Asia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Broussonetia papyrifera (L.) L'Her.ex Vent.	Moraceae	Woody tree/ shrub	Ornament, silvicultural crop	Asia - nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Eucalyptus bridgesiana F. Muell. ex R.T. Baker	Myrtaceae	Woody tree/ shrub	Domestic, ornament, silvicultural crop	Australia - temperate	?Witt, *pers. obs.*	
Eucalyptus camaldulensis Dehnh	Myrtaceae	Woody tree/ shrub	Domestic, ornament, silvicultural crop	Australia - temperate	Witt, *pers. obs.*	
Eucalyptus globulus ssp. *maidenii* (F. Muell.) J.B. Kirkp.	Myrtaceae	Woody tree/ shrub	Domestic, ornament, silvicultural crop	Australia - temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Eucalyptus grandis W. Hill	Myrtaceae	Woody tree/ shrub	Domestic, ornament, silvicultural crop	Australia - temperate	?Witt, *pers. obs.*	
Eucalyptus tereticornis Sm.	Myrtaceae	Woody tree/ shrub	Domestic, ornament, silvicultural crop	Australia - temperate	?Witt, *pers. obs.*	
Psidium guajava L.	Myrtaceae	Woody tree/ shrub	Agricultural crop (food), domestic, ornament	America - tropical	Flora Zambesiaca; Witt, *pers. obs.*	Witt, *pers. obs.*
Nephrolepis cordifolia (L.) K.Presl*	Nephrolepidaceae	Fern	Ornament	?Asia and N. Australia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Mirabilis jalapa L.	Nyctaginaceae	Herb	Ornament	S. America – sth temperate	Shah and Makhambera (2019); Witt, *pers. obs.*	Shah and Makhambera (2019); Witt, *pers. obs.*
Ligustrum lucidum W.T. Aiton	Oleaceae	Woody tree/ shrub	Barrier, ornament	Asia - nth temperate	Witt, *pers. obs.*	
Argemone mexicana L.	Papaveraceae	Herb	None	America - tropical	Flora of Zambia (2020); Williamson (1954); Witt, *pers. obs.*	Flora of Zambia (2020); Witt, *pers. obs.*
Argemone ochroleuca Sweet	Papaveraceae	Herb	None	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Passiflora edulis Sims	Passifloraceae	Climber	Agricultural crop (food), ornament	America: tropical	Williamson (1954); Witt, *pers. obs.*	

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Pinus oocarpa Schiede	Pinaceae	Woody tree/ shrub	Barrier, domestic, ornament, silvicultural crop	America - tropical	?Witt, *pers. obs.*	
Pinus patula Schiede ex Schltdl. & Cham.	Pinaceae	Woody tree/ shrub	Barrier, domestic, ornament, silvicultural crop	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Pinus taeda L.	Pinaceae	Woody tree/ shrub	Barrier, domestic, ornament, silvicultural crop	America - tropical	?Witt, *pers. obs.*	
Arundo donax L.	Poaceae	Grass	Agricultural crop (biofuel), domestic, ornament	Mediterranean and N. Africa – nth temperate	Sikatala *et al.* (2019)	?Sikatala *et al.* (2019)
Pennisetum setaceum (Forssk.) Chiov.*	Poaceae	Grass	Ornament, rehabilitation	Africa - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Persicaria capitata (Buch.-Ham. ex D. Don) H. Gross	Polygonaceae	Herb	Medicinal, ornament	Asia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Pontederia cordata L.	Pontederiaceae	Aquatic	Ornament	America - tropical	?Witt, *pers. obs.*	
Pontederia crassipes Mart.	Pontederiaceae	Aquatic	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Crataegus mexicana (Loudon) Rehder	Rosaceae	Woody tree/ shrub	Agricultural crop (food), domestic, medicinal, ornament	America - tropical	Witt, *pers. obs.*	
Rubus ellipticus	Rosaceae	Woody tree/ shrub	Agricultural crop (food), barrier, medicine, ornament	Asia – nth temperate	Williamson (1954); Witt, *pers. obs.*	Williamson (1954); Witt, *pers. obs.*
Rubus niveus Thunb.	Rosaceae	Woody tree/ shrub	Agricultural crop (food), barrier, ornament	Asia - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Pyracantha angustifolia (Franch.) C.K. Schneid	Rosaceae	Woody tree/ shrub	Barrier, ornament	Asia – nth temperate	Flora of Malawi (2020); Witt, *pers. obs.*	
Pyracantha crenulata (D. Don) M. Roem	Rosaceae	Woody tree/ shrub	Barrier, ornament	Asia – nth temperate	Flora of Malawi (2020); Witt, *pers. obs.*	
Salvinia molesta D.S. Mitch.	Salviniaceae	Aquatic	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Cardiospermum grandiflorum Sw.	Sapindaceae	Climber	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Digitalis purpurea L.	Scrophulariaceae	Herb	Ornament	Europe – nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & J. Presl	Solanaceae	Woody tree/ shrub	Ornament	America -tropical	?Witt, *pers. obs.*	
Datura innoxia Mill.	Solanaceae	Herb	None	America - tropical	Flora Zambesiaca; Witt, *pers. obs.*	Witt, *pers. obs.*
Datura metel	Solanaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Datura stramonium L.	Solanaceae	Herb	Ornament	America - tropical	Williamson (1954); Witt, *pers. obs.*	Williamson (1954); Witt, *pers. obs.*

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Species	Family	Growth form	Cultivated use	Origin	Naturalized	Invasive
Nicandra physalodes (L.) Gaertn.	Solanaceae	Herb	Ornament	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Nicotiana glauca Graham	Solanaceae	Woody tree/ shrub	Medicinal, ornament	South America - sth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*
Physalis peruviana L.	Solonaceae	Herb	Agricultural crop (food)	America - tropical	Williamson (1954); Witt, *pers. obs.*	Williamson (1954)
Solanum chrysotrichum Schltdl	Solanaceae	Woody tree/ shrub	Medicinal	America - tropical	Witt, *pers. obs.*	Witt, *pers. obs.*
Solanum seaforthianum Andrews	Solanaceae	Climber	Ornament	America - tropical	Pickering and Roe (2009); Witt, *pers. obs.*	Pickering and Roe (2009); Witt, *pers. obs.*
Solanum torvum Sw.	Solanaceae	Woody tree/ shrub	Ornament	America - tropical	Witt, *pers. obs.*	
Lantana camara L.	Verbenaceae	Woody tree/ shrub	Barrier, medicinal, ornament	America - tropical	Pickering and Roe (2009); Shah and Makhambera (2019); Witt, *pers. obs.*	Pickering and Roe (2009); Shah and Makhambera (2019); Witt, *pers. obs.*
Stachytarpheta jamaciensis (L.) Vahl	Verbeaceae	Herb	Ornament	America -tropical	Witt, *pers. obs.*	
Hedychium flavescens Carey ex Roscoe	Zingiberaceae	Herb	Ornament	Asia - nth temperate	Witt, *pers. obs.*	Witt, *pers. obs.*

? = uncertainty as to identification or origin and classification as naturalized or invasive; *= Possibly native to Malawi and Zambia

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Appendix B

Biological control agents that have established in Malawi and/or Zambia or elsewhere on some of the species of plants included in this Field Guide (from Winston *et al.*, 2014; https://www.ibiocontrol.org/catalog/; and R.L. Winston, *pers. comm*.)

Species	Plant family	Agent family	Agent species	Country/countries established
Pistia stratiotes L.	Araceae	Curculionidae	*Neohydronomus affinis* Hustache	Australia, Benin, Botswana, Ghana, Ivory Coast, Kenya, Morocco, Mozambique, Nigeria, Papua New Guinea, Puerto Rico*, Republic of Congo, Republic of South Africa, Senegal, Togo, United States of America, Vanuatu, Zambia, Zimbabwe
		Noctuidae	*Spodoptera pctinicornis* (Hampson)	Thailand
Tithonia diversifolia (Hemsl.) A. Gray	Asteraceae	Chrysomelidae	*Physonota maculiventris* Boheman	Republic of South Africa*
Tithonia rotundifolia (Mill.) S.F. Blake	Asteraceae	Chrysomelidae	*Zygogramma piceicollis* (Stål)	Republic of South Africa*
		Chrysomelidae	*Zygogramma signatipennis* (Stål)	Republic of South Africa*
Xanthium strumarium L.	Asteraceae	Tortricidae	*Epiblema strenuana* (Walker)	Australia
		Tephritidae	*Euaresta aequalis* Loew	Australia
		Cerambycidae	*Mecas cana* ssp. *saturnina* (LeConte)	Australia*
		Cerambycidae	*Nupserha vexator* (Pascoe)	Australia
		Chrysomelidae	*Ophraella communa* LeSage	Japan
		Pucciniales	*Puccinia xanthii* Schweinitz	Australia
Azolla filiculoides Lam.	Azollaceae	Erirhinidae	*Stenopelmus rufinasus* Gyllenhal	Belgium, England, France, Germany, Hungary, Italy, Mozambique, Netherlands, Northern Ireland, Portugal, Republic of Ireland, Republic of South Africa, Slovakia, Spain, Ukraine, Wales, Zimbabwe
Anredera cordifolia (Ten.) Steenis	Basellaceae	Chrysomelidae	*Plectonycha correntina* Lacordaire	Australia, Republic of South Africa*
Dolichandra unguis-cati (L.) L.G. Lohmann	Bignoniaceae	Tingidae	*Carvalhotingis hollandi* Drake	Republic of South Africa*
			Carvalhotingis visenda Drake & Hambleton	Australia, Republic of South Africa
		Chrysomelidae	*Charridotis auroguttata* Boheman	Republic of South Africa
		Buprestidae	*Hylaeogena jureceki* Obenberger	Australia*, Republic of South Africa
		Pyralidae	*Hypocosmia pyrochroma* Jones	Australia*, Republic of South Africa*
Spathodea campanulata P. Beauv.	Bignoniaceae	Acari	*Colomerus spathodeae* (Carmona)	Cook Islands
Tecoma stans (L.) Juss. Ex Kunth	Bignoniaceae	Coccinellidae	*Mada polluta* Mulsant	Republic of South Africa
		Agromyzidae	*Pseudonapomyza* sp.	Republic of South Africa

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Species	Plant family	Agent family	Agent species	Country/countries established
?*Acanthocereus tetragonus* (L.) Hummelinck	Cactaceae	Pseudococcidae	*Hypogeococcus pungens* complex	Australia
Opuntia ficus-indica (L.) Mill.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Cuba, Hawaii USA, Puerto Rico, Republic of South Africa, U.S. Virgin Islands
		Dactylopiidae	*Dactylopius opuntiae* (Cockerell)	Hawaii USA, Republic of South Africa, Spain
		Hypocreales	*Fusarium oxysporum* Schlecktendahl	Hawaii USA
		Cerambycidae	*Lagocheirus funestus* Thomson	Hawaii USA, Republic of South Africa
		Dryophthoridae	*Metamasius spinolae* (Gyllenhal)	Republic of South Africa
Opuntia monacantha (Willd.) Haw.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Cuba, Mauritius
		Dactylopiidae	*Dactylopius ceylonicus* (Green)	Australia, India, Mauritius, Republic of South Africa, Sri Lanka
			Dactylopius confusus (Cockerell)	Australia
		Dactylopiidae	*Dactolopius opuntiae* (Cockerell)	Mauritius
Opuntia stricta (Haw.) Haw.	Cactaceae	Pyralidae	*Cactoblastis cactorum* (Berg)	Antigua, Australia, Bahamas, Cayman Islands, Cuba, Federation of St Kitts and Nevis, Guadeloupe, Jamaica, Montserrat, New Caledonia, Puerto Rico, Republic of South Africa, U.S. Virgin Islands
		Coreidae	*Chelinidea tabulata* (Burmeister)	Australia
			Chelinidea vittiger Uhler	Australia*
		Dactylopiidae	*Dactylopius confusus* Cockerell	Australia
			Dactolopius opuntiae (Cockerell)	Australia, Federation of St Kitts and Nevis, India, Kenya, Republic of South Africa, Sri Lanka
		Cerambycidae	*Moneilema blapsides* (Newman) ssp. *ulkei* Horn	Australia
		Cerambycidae	*Moneilema variolare* Thomson	Australia
		Pyralidae	*Olycella junctolineella* (Hulst)	Australia
Acacia dealbata Link	Fabaceae	Curculionidae	*Melanterius maculatus* Lea	Republic of South Africa
Acacia mearnsii De Wild.	Fabaceae	Agaricales	*Cylindrobasidium laeve* (Pers.)	Republic of South Africa
		Cecidomyiidae	*Dasineura rubiformis* Kolesik	New Zealand, Republic of South Africa
		Curculionidae	*Melanterius maculatus* Lea	Republic of South Africa
Acacia melanoxylon R. Br.	Fabaceae	Curculionidae	*Melanterius acaciae* Lea	Republic of South Africa

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Species	Plant family	Agent family	Agent species	Country/countries established
Caesalpinia decapetala (Roth) Alston	Fabaceae	Chrysomelidae	*Sulcobruchus subsuturalis* (Pic)	Republic of South Africa
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Chrysomelidae	*Acanthoscelides macrophthalmus* Schaeffer	Australia, Benin, India, Japan, People's Republic of China, Republic of Cyprus, Republic of South Africa, Senegal, Taiwan, Thailand, Togo, Vietnam
Mimosa diplotricha Sauvalle	Fabaceae	Psyllidae	*Heteropsylla spinulosa* Muddiman, Hodkinson & Hollis	American Samoa, Australia, Cook Islands, Federated States of Micronesia, Fiji, Guam, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor Leste, Tonga, Vanuatu
Mimosa pigra L.	Fabaceae	Chrysomelidae	*Acanthoscelides puniceus* Johnson	Australia, Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Papua New Guinea*, Singapore, Thailand, Vietnam
			Acanthoscelideser quadridentatus (Schaeffer)	Indonesia, Lao People's Democratic Republic, Malaysia, Myanmar, Papua New Guinea*, Singapore, Thailand, Vietnam
		Sesiidae	*Carmenta mimosa* Eichlin & Passoa	Australia, Malaysia, Vietnam, Zambia
		Curculionidae	*Chalcodermus serripes* Fåhraeus	Australia
		Chrysomelidae	*Chlamisus mimosa* Karren	Australia, Thailand*, Vietnam*
		Brentidae	*Coelocephalapion pigrae* Kissinger	Australia
		Pucciniales	*Diabole cubensis* (Arthur & J. R. Johnst.) Arthur	Australia
		Geometridae	*Leuciris fimbriaria* (Stoll)	Australia
			Macaria pallidata (Warren)	Australia
		Chrysomelidae	*Malacorhinus irregularis* Jacoby	Australia
			Nesaecrepida infuscata (Schaeffer)	Australia
		Gracillariidae	*Neurostrota gunniella* (Busck)	Australia
		Cerambycidae	*Rhytiphora piperitia* Hope	Australia
Parkinsonia aculeata L.	Fabaceae	Chrysomelidae	*Mimosestes ulkei* (Horn)	Australia*
		Chrysomelidae	*Penthobruchus germaini* (Pic)	Australia
		Miridae	*Rhinacloa callicrates* Herring	Australia
Prosopis juliflora (Sw.) DC.	Fabaceae	Chrysomelidae	*Algarobius bottimeri* Kingsolver	Australia

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Species	Plant family	Agent family	Agent species	Country/countries established
		Chrysomelidae	*Algarobius prosopis* (Le Conte)	Ascension Island, Australia, Botswana, Egypt, Namibia, Oman, Republic of South Africa, Saudi Arabia, United Arab Emirates, Yemen
		Gelechiidae	*Evippe* sp. # 1	Australia, Republic of South Africa*
		Psyllidae	*Heteropsylla reducta* Caldwell & Martorell	Ascension Island
		Chrysomelidae	*Neltumius arizonensis* (Schaeffer)	Ascension Island, Botswana, Namibia, Republic of South Africa
		Psyllidae	*Prosopidopsylla flava* Burckhardt	Australia
		Miridae	*Rhinocloa* sp.	Ascension Island
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Chrysomelidae	*Lysathia* sp.	Republic of South Africa, Zimbabwe
Arundo donax L.	Poaceae	Diaspididae	*Rhizaspidiotus donacis* Leonardi	Mexico, USA
		Eurytomidae	*Tetramesa romana* Walker	Mexico, USA
Pontederia crassipes Mart.	Pontederiaceae	Hypocreales	*Acremonium zonatum* (Sawada) W. Gams	Mexico
		Pleosporales	*Alternaria eichhorniae* Nag Raj & Ponnappa	Egypt, Republic of South Africa
		Noctuidae	*Bellura densa* (Walker)	United States of America
		Capnodiales	*Cercospora piaropi* Tharp	Mexico, United States of America, Republic of South Africa
		Acrididae	*Cornops aquaticum* Bruner	Republic of South Africa*
		Miridae	*Eccritotarsus catarinensis* (Carvalho)	Ghana, Malawi, Republic of South Africa
		Delphacidae	*Megamelus scutellaris* Berg	Republic of South Africa, United States of America
		Erirhinidae	*Neochetina bruchi* Hustache	Argentina, Australia, Benin, Bolivia, Burkina Faso, Cuba, Egypt, Ghana, Honduras, India, Indonesia, Ivory Coast, Kenya, Malawi, Malaysia, Mali, Mexico, Mozambique, Niger Republic*, Nigeria, Panama*, Papua New Guinea, People's Republic of China, Philippines*, Republic of Congo, Republic of South Africa, Rwanda, South Sudan, Sri Lanka, Sudan, Tanzania, Thailand, Togo, Uganda, United States of America, Vanuatu, Vietnam, Zambia, Zimbabwe

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Species	Plant family	Agent family	Agent species	Country/countries established
		Erirhinidae	*Neochetina eichhorniae* Warner	Australia, Benin, Bolivia, Burkina Faso, Cuba, Egypt, Fiji, Ghana, Honduras, India, Indonesia, Ivory Coast, Kenya, Malawi, Malaysia, Mali, Mexico, Mozambique, Myanmar, Nauru*, Niger Republic, Nigeria, Papua New Guinea, People's Republic of China, Philippines*, Republic of Congo, Republic of South Africa, Rwanda, Solomon Islands, South Sudan, Sri Lanka, Sudan, Tanzania, Thailand, Togo, Uganda, United States of America, Vanuatu, Vietnam*, Zambia, Zimbabwe
		Crambidae	*Niphograpta albiguttalis* (Warren)	Australia, Benin, Cuba, Ghana, Kenya, Malawi*, Malaysia, Mexico, Nigeria, Panama*, Puerto Rico, Republic of South Africa, South Sudan, Thailand, United States of America, Zimbabwe
		Galumnidae	*Orthogalumna terebrantis* Wallwork	Cuba, India, Jamaica, Malawi, Mozambique, Republic of South Africa, United States of America, Zambia, Zimbabwe
		Crambidae	*Xubida infusella* (Walker)	Australia, Papua New Guinea*, Thailand
Salvinia molesta D.S. Mitch.	Salvinaceae	Erirhinidae	*Cyrtobagous salviniae* Calder & Sands	Australia, Botswana, Fiji, Ghana, India, Indonesia, Ivory Coast, Kenya, Malaysia, Mali, Mauritania, Namibia, Papua New Guinea, Philippines, Republic of Congo, Republic of South Africa, Senegal, Sri Lanka, Togo, Zambia, Zimbabwe
			Cyrtobagous singularis Hustache	Botswana, Fiji, Zambia, Zimbabwe
		Pauliniidae	*Paulinia acuminata* (De Geer)	Fiji, Mozambique, Zambia, Zimbabwe
		Crambidae	*Samea multiplicalis* (Guenée)	Australia, Fiji
Cardiospermum grandiflorum Sw.	Sapindaceae	Curculionidae	*Cissoanthonomus tuberculipennis* Hustache	Republic of South Africa*
		Pucciniales	*Puccinia arechavaletae* Speg.	Cook Islands, Republic of South Africa
Lantana camara L.	Verbenaceae	Eriophyidae	*Aceria lantanae* (Cook)	Australia*, Republic of South Africa, United States of America
		Membracidae	*Aconophora compressa* Walker	Australia

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Species	Plant family	Agent family	Agent species	Country/countries established
		Agromyzidae	*Calycomyza lantanae* (Frick)	Australia, Benin, Cambodia, Ethiopia, Federated States of Micronesia, Fiji, Guam, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Palau, Papua New Guinea, Philippines, Republic of South Africa, Singapore, Solomon Islands, Sri Lanka, Swaziland, Taiwan, Tanzania, Thailand, Timor Leste, Uganda, Vanuatu, Vietnam, Zimbabwe
		Brentidae	*Coelocephalapion camarae* Kissinger	Republic of South Africa
		Gracillariidae	*Cremastobombycia lantanella* Busck	Hawaii USA
		Torticidae	*Crocidosema lantana* Busck	Australia, Federated States of Micronesia, Guam, Hawaii USA, India, Marshall Islands, Northern Mariana Islands, Palau, Republic of South Africa, Sri Lanka, Vanuatu, Zimbabwe
		Noctuidae	*Diastema tigris* Guenée	Mauritius
		Tephritidae	*Eutreta xanthochaeta* Aldrich	Hawaii USA
		Miridae	*Falconia intermedia* (Distant)	Australia, Republic of South Africa
		Erebidae	*Hypena laceratalis* Walker	Australia, Cape Verde Islands, Federated States of Micronesia, Fiji, Guam, Hawaii USA, Mauritius, New Caledonia, Northern Mariana Islands, Papua New Guinea, Philippines, Republic of South Africa, Taiwan*, Vanuatu
		Pterophoridae	*Lantanophaga pusillidactyla* (Walker)	Australia, Federated States of Micronesia, Guam, Hawaii USA, Hong Kong, India, Israel, Italy, Morocco, Myanmar, New Zealand, Northern Mariana Islands, Palau, Papua New Guinea, People's Republic of China, Philippines, Portugal, Republic of South Africa, Spain, Sri Lanka, Taiwan, Thailand, Timor Leste, Zambia, Zimbabwe
		Tingidae	*Leptobyrsa decora* Drake	Australia, Cook Islands*, Hawaii USA, Tonga*
		Chrysomelidae	*Longitarus bethae* Savini & Escalona	Republic of South Africa

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Species	Plant family	Agent family	Agent species	Country/countries established
		Noctuidae	*Neogalea sunia* (Guenée)	Australia, Hawaii USA, New Caledonia
		Chrysomelidae	*Octotoma championi* Baly	Australia
			Octotoma scabripennis Guérin-Méneville	Australia, Ghana, Guam, Hawaii USA, India, New Caledonia, Republic of South Africa, Solomon Islands*, Swaziland
		Agromyzidae	*Ophiomyia camarae* Spencer	Argentina, Ethiopia, Kenya, Madagascar, Mozambique, Swaziland, Tanzania, Zimbabwe,
			Ophiomyia lantanae (Froggatt)	Argentina, Australia, Benin, Cook Islands*, Ethiopia, Federated States of Micronesia, Fiji, French Polynesia, Ghana, Guam, Hawaii USA, Hong Kong, India, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Mozambique, Myanmar, New Caledonia, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of South Africa, Samoa, Singapore, Sri Lanka, Swaziland, Taiwan, Tanzania, Thailand, Timor Leste, Tonga, Vanuatu, Vietnam, Zambia, Zimbabwe
		Ortheziidae	*Orthezia insignis* Browne	Ascension Island, Cape Verde Islands, Ethiopia, Hawaii USA, India, Kenya, La Réunion, Mauritius, Republic of South Africa, Sri Lanka, St Helena, Swaziland
		Capnodiales	*Passalora lantanae* var. *lantanae* (Chupp) U. Braun	Sri Lanka
		Pseudococcidae	*Phenacoccus parvus* Morrison	Australia
		Cerambycidae	*Plagiohammus spinipennis* (Thomson)	Australia
		Pucciniales	*Prospodium tuberculatum* (Spegazzini) Arthur	Australia
		Crambidae	*Salbia haemorrhoidalis* Guenée	Australia, Benin, Federated States of Micronesia, Fiji, Hawaii USA, Mauritius, Republic of South Africa, Uganda, Zambia
		Capnodiales	*Septoria* sp.	Hawaii USA
		Lycaenidae	*Strymon bazochii* (Godart)	Fiji, Hawaii USA*

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Species	Plant family	Agent family	Agent species	Country/countries established
		Tingidae	*Teleonemia scrupulosa* Stål	Ascension Island, Australia, Benin, Botswana, Federated States of Micronesia, Fiji, French Polynesia, Ghana, Guam, Hawaii USA, India, Indonesia, Kenya, La Réunion, Madagascar, Malaysia, Mauritius, Namibia, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of South Africa, Samoa, Solomon Islands, Sri Lanka, St Helena, Swaziland, Tanzania, Thailand, Timor Leste, Tonga, Uganda, Vanuatu, Zambia, Zimbabwe
		Lycaenidae	*Tmolus echion* (L.)	Hawaii USA
		Chrysomelidae	*Uroplata fulvopustulata* Baly	Australia
			Uroplata girardi Pic	Ascension Island, Australia, Cook Islands, Ethiopia, Federated States of Micronesia, Fiji, Ghana, Guam, Hawaii USA, India, Mauritius, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Philippines, Republic of South Africa, Samoa, Solomon Islands, St Helena*, Tanzania, Tonga, Trinidad and Tobago*, Uganda, Vanuatu, Zambia

*Released but establishment not yet confirmed

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Appendix C

Herbicides registered or permissible with minor or emergency use permits in Australia by the Australian Pesticides and Veterinary Medicines Authority, against some of the plant species included in this Field Guide (Joseph Vitelli, Department of Agriculture and Fisheries, Queensland Government, Australia; *pers. comm*.). Additional information from New South Wales Weed Control Handbook - A guide to weed control in non-crop, aquatic and bushland situations, 7th edition, Department of Primary Industries (Cook *et al.*, 2018). Please read and adhere to product labels.

(Abbreviations used: g/L = grams/litre; g/kg = grams per kilogram)

Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of application
Hypoestes phyllostachya Baker	Acathaceae	Glyphosate	Glyphosate (360g/L)	0.1g/L water	Foliar
Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.	Acanthaceae	Imazapyr	Imazapyr (250g/L)	0.25g/L water	Cut stump ("V" shape cut 2mls/cut)
		Imazapyr	Imazapyr (250g/L)	1.875g/L water	Foliar
		Imazapyr + Glyphosate	Imazapyr (150g/L) + Glyphosate (150g/L)	1.875 + 1.875g/L water	Foliar
Agave americana L.	Agavaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Agave angustifolia Haw.	Agavaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Agave sisalana Perrine	Agavaceae	Fluroxypyr	Fluroxypyr (333g/L)	6g/L diesel	Foliar
		Imazapyr	Imazapyr (250g/L)	1.25g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Foliar
Furcraea foetida (L.) Haw.	Agavaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
Calotropis procera (Aiton) Dryand.	Apocynaceae	Fluroxypyr	Fluroxypyr (333g/L)	10.0g/L diesel	Basal bark
		Imazapyr	Imazapyr (250g/L)	1.25g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Basal bark/Cut stump
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5mm layer	Cut stump
		Glyphosate	Glyphosate (360g/L)	360g/L water	Cut stump
		Tebuthiuron	Tebuthiuron (200g/L)	0.2g per metre square of soil around plant	Spot ground application
Cascabela thevetia (L.) Lippold	Apocynaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	1.2g/L water	Cut stump
		Fluroxypyr	Fluroxypyr (333g/L)	3.0g/L diesel	Basal bark
		Triclopyr + Picloram	Triclopyr (200 g/L) + Picloram (100 g/L)	50.0g+25.0g/L water	Stem injection
		Glyphosate	Glyphosate (360g/L)	1.8g/L water	Stem injection
Catharanthus roseus (L.) G.Don	Apocynaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	3.5g + 0.35g/L water	Foliar

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Pistia stratiotes L.	Araceae	Diquat	Diquate (200g/L)	0.67g/L water	Foliar
		Flumioxazin	Flumioxazin (500g/L)	0.7g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	4.68g/L water	Foliar
		2,4-D	2,4-D (300g/L)	5mL/L water	Foliar
		Metsulfuron-methyl 600 g/kg	Metsulfuron-methyl (600g/kg)	0.1g/L water + wetter	Foliar
Ageratum conyzoides (L.) L.	Asteraceae	Fluroxypyr	Fluroxypyr (333g/L)	0.25g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	1g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
Ageratum houstonianum Mill.	Asteraceae	See *A. conyzoides*			
Dahlia imperialis Roezl ex Ortgies	Asteraceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Sphagneticola trilobata (L.) Pruski	Asteraceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
		Glyphosate 360 g/L	Glyphosate 360 g/L	20mL/L water	Foliar
		Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/kg)	20mL + 1.5g/L water	Foliar
Tithonia diversifolia (Hemsl.) A.Gray	Asteraceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.075g + 0.06g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water	Foliar
		Picloram + Triclopyr + Aminopyralid	Picloram (100g/L) + Triclopyr (300g/L) + Aminopyralid (8 g/L)	5 mL/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	5mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	6.5mL/L water	Foliar
		Amitrole + Ammonium thiocyanate	Amitrole (250g/L) + Ammonium thiocyanate (220g/L)	11mL/L water	Foliar
		Triclopyr	Triclopyr (600g/L)	1.7mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Scrape and paint
		Picloram	Picloram (45g/kg)	Neat: 3-5 mm layer	Cut stump
		Picloram + Aminopyralid	Picloram (44.7g/L) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	33mL/L of diesel	Basal bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	17mL/L diesel	Basal bark
Tithonia rotundifolia (Mill.) S.F. Blake	Asteraceae	See *Tithonia diversifolia*			
Tithonia tubaeformis (Jacq.) Cass	Asteraceae	See *Tithonia diversifolia*			
Xanthium strumarium L.	Asteraceae	2,4-D	2,4-D Amine (625g/L)	1.9g/L water	Foliar

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		2,4-D + Picloram	2,4-D Amine (300g/L) + Picloram (75g/L)	200g + 50g/L water	Foliar
		Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.0525g + 0.042g/L water + wetter	Foliar
		Dicamba	Dicamba (500g/L)	3.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	0.15g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	0.625g/L water	Foliar
		MCPA	MCPA (500g/L)	1.33g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.038g/L water + wetter	Foliar
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.15g + 0.06g/L water + wetter	Foliar
Azolla filiculoides Lam.	Azollaceae	Calcium dodecyl benzene sulfonate	Calcium dodecyl benzene sulfonate (300g/L)	15g/L kerosene per 100m^2	Foliar
		Diquat	Diquat (200g/L)	1.67g/L water	Foliar
Anredera cordifolia (Ten.) Steenis	Basellaceae	Fluroxypyr	Fluroxypyr (200g/L)	1.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	3mL/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	4mL/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
		Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/kg)	0.2mL Glyphosate + 1.5 g Metsulfuron-methyl/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	10mL/L water + surfactant	Foliar
		Glyphosate	Glyphosate (360g/L)	Neat	Stem scraping
		Glyphosate	Glyphosate (360g/L)	360g/L water	Cut stump; immerse both cut ends of the vine into the prepared herbicide solution and leave until solution is no longer being absorbed
		Picloram	Picloram (45g/kg)	Neat: 3-5 mm layer	Cut stump/ Stem injection
		Picloram + Aminopyralid	Picloram (44.7g/L) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump/ Stem injection
Dolichandra unguis-cati (L.) L.G.Lohmann	Bignoniaceae	Glyphosate	Glyphosate (360g/L)	3.6g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + picloram (100g/L)	4 mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	30g/L water	Cut stump
		Picloram	Picloram (45g/kg)	Neat: 3-5 mm layer	Cut stump/ Stem injection
Tecoma stans (L.) Juss ex Kunth	Bignoniaceae	Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	16.67mL/L diesel	Cut stump/ Basal bark
		Picloram	Picloram (45g/kg)	Neat: 3-5 mm layer	Cut stump/ Stem injection

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		Picloram + Aminopyralid	Picloram (44.7g/kg) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump/ Stem injection
Opuntia ficus-indica (L.) Mill.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Opuntia monacantha (Willd.) Haw.	Cactaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
		Triclopyr	Triclopyr (600g/L)	13.3mL/L water	Foliar
Opuntia stricta (Haw.) Haw.	Cactaceae	Amitrole + Ammonium Thiocyanate	Amitrole (250g/L) + Ammonium Thiocyanate (220g/L)	10g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		MSMA	MSMA (800g/kg)	18g/L water + wetter	Foliar
		Picloram + Fluroxypyr + Polysiloxane	Picloram (240g/L) + Fluroxypyr (333g/L) + 1020g/L Polysiloxane	0.5g + 0.42g + 1.7g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	5g + 2.5g + 0.625/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Canna indica L.	Cannaceae	Glyphosate	Glyphosate (360g/L)	3.6 g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06 g/L + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Picloram	Picloram (45g/kg)	Neat: 3 to 5 mm layer across surface of rhizome	Cut stump
Canna x generalis L.H. & E.Z. Bailey	Cannaceae	See *Canna indica*			
Lonicera japonica Thunb.	Caprifoliaceae	Glyphosate	Glyphosate (360g/L)	667mL/L water	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1–0.2g/L water	Foliar
Callisia fragrans (Lindl.) Woodson	Commelinaceae	Glyphosate	Glyphosate (360g/L)	7.2g/L water	Foliar
Tradescantia zebrina Bosse	Commelinaceae	Fluroxypyr	Fluroxypyr (333g/L)	3g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water	Foliar
Ipomoea carnea Jacq.	Convolvulaceae	Flumioxazin	Flumioxazin (500g/L)	0.35g/L water	Foliar
Ipomoea alba L.	Convolvulaceae	Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/L)	20 mL + 0.15g/L water	Foliar
		Dichlorprop	Dichlorprop (600g/L)	5mL/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + picloram (100g/L) + Aminopyralid (8g/L)	5mL/L water	Foliar

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		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	50mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Stem scraping
		Picloram	Picloram (45g/kg)	Neat: 3-5mm layer	Cut stump/ Stem injection
Ipomoea indica (Burm.) Merr.	Convolvulaceae	Dichlorprop	Dichlorprop (600g/L)	5mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL + 0.15g of metsulfuron-methyl/L water	Foliar
		Picloram + Triclopyr +Aminopyralid	Picloram (100g/L) + Triclopyr (300g/L) + Aminopyralid (8g/L)	5mL/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	5mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Stem scraping
		Picloram + Aminopyralid	Picloram (44.7g/L) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump
Ipomoea purpurea (L.) Roth	Convolvulaceae	Fluroxypyr	Fluroxypyr (200g/L)	5–10mL/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	3–6 mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	111mL/L water	Foliar – splatter gun
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1-0.2g/L water + surfactant	Foliar
		Glyphosate 360 g/L	Glyphosate (360g/L)	50mL/L water	Wipe onto leaves
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	10g/L water + surfactant	Wipe onto leaves
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Scrape and paint
		Fluroxypyr	Fluroxypyr (200g/L)	35mL/L diesel/ kerosene	Basal bark
		Fluroxypyr	Fluroxypyr (333g/L)	21mL/L diesel/ kerosene	Basal bark
Bryophyllum spp.	Crassulaceae	Picloram + Triclopyr + Aminopyralid	Picloram (100g/L) + Triclopyr (300g/L) + Aminopyralid (8g/L)	5mL/L water + surfactant	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	5mL/L water + surfactant	Foliar
		2,4-D	2,4-D (300g/L)	7mL/L water	Foliar
		2,4-D Amine	2,4-D Amine (625g/L)	4mL/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	36mL/L water	Foliar
		Fluroxypyr	Fluroxypyr (200g/L)	6mL/L water	Foliar
		Glyphosate with Metsulfuron-methyl	Glyphosate (360g/L) with Metsulfuron-methyl (600g/kg)	2mL + 0.1g/ water + surfactant	Foliar
Bryophyllum daigremontianum (Raym.-Hamet & Perrier) A. Berger	Crassulaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
Bryophyllum delagoense (Eckl. & Zeyh.) Druce	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar

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		Metsulfuron-methyl + Glyphosate	Metsulfuron-methyl (600g/kg) + Glyphosate (360g/L)	0.06g/L + 0.72g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	1.5g/L + 0.5g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
		2,4-D	2,4-D (300g/L)	7mL/L water	Foliar
		2,4-D	2,4-D amine (625g/L)	4mL/L water	Foliar
Bryophyllum pinnatum (Lam.) Oken	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
		Metsulfuron-methyl + Glyphosate	Metsulfuron-methyl (600g/kg) + Glyphosate (360g/L)	0.06g/L + 0.72g/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	1.5g/L + 0.5g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g/L + 0.5g/L + 0.04g/L water + wetter	Foliar
Bryophyllum proliferum Bowie ex Hook.	Crassulaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.2g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.12g/L water + wetter	Foliar
Pteridium esculentum (G.Forst.) Cockayne*	Dennstaedtiaceae	Glyphosate	Glyphosate (360g/L)	15mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	9.0L/ha	Boom spray
		Glyphosate	Glyphosate (360g/L)	0.5L/L water	Wiper application
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/kg)	0.2g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	60g/ha	Boom spray
Jatropha curcas L.	Euphorbiaceae	See *J. gossypifolia*			
Jatropha gossypifolia L.	Euphorbiaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/L)	0.06g + 0.075g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water + wetter	Foliar
Ricinus communis L.	Euphorbiaceae	2,4-D	2,4-D Amine (625g/L)	1.76g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Cut stump/ Stem injection

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		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Cut stump/ Basal bark
Acacia mearnsii De Wild.	Fabaceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.07g/L + 0.98g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	2.0g/L water + wetter	Foliar
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Cut stump/ Basal Bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Acacia melanoxylon R. Br.	Fabaceae	Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.07g/L + 0.98g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	2.0g/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Cut stump/ Basal bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g+2g/L diesel	Cut stump/ Basal bark
Albizia chinensis (Osbeck) Merr.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Albizia lebbeck (L.) Benth.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Bauhinia purpurea L.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Bauhinia variegata L.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Cut stump/ Basal bark
Caesalpinia decapetala (Roth) Alston	Fabaceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.075g + 0.06g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
		Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/L)	0.06g + 0.075g/L water + wetter	Foliar
		Triclopyr + Metsulfuron	Triclopyr (75g/L) + Metsulfuron (28g/L)	0.19g + 0.07g/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5 mm layer	Cut stump
Delonix regia (Hook.) Raf.	Fabaceae	Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Leucaena leucocephala (Lam.) de Wit	Fabaceae	Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Mimosa diplotricha Sauvalle	Fabaceae	Dicamba	Dicamba (500g/L)	2.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glufosinate ammonium	Glufosinate ammonium (200g/L)	1.0g/L water	Foliar
Mimosa pigra L.	Fabaceae	Aminopyralid + Metsulfuron	Aminopyralid (375g/kg) + Metsulfuron (300g/kg)	0.11g + 0.09g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.09g/L water + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	1.2g/L water + wetter	Cut stump

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		Tebuthiuron	Tebuthiuron (200g/L)	0.2g/metre square of soil around plant	Spot ground application
Mimosa pudica L.	Fabaceae	Dicamba	Dicamba (500g/L)	2.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	0.6g + 0.2g + 0.016/L water	Foliar
Parkinsonia aculeata L.	Fabaceae	Triclopyr + Picloram	Triclopyr (300g/L)+ Picloram (100g/L)	1.0g + 0.35g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
		Hexazinone	Hexazinone (250g/L)	1.0g/spot per tree applied to the soil for trees > 1m tall	Spot ground application
		Hexazinone	Hexazinone (250g/L)	0.25g/spot per tree applied to the soil for trees up to 1m tall	Spot ground application
		Tebuthiuron	Tebuthiuron (200g/L)	0.3g/metre square of soil around tree	Spot ground application
Prosopis spp.	Fabaceae	Picloram + Triclopyr + Aminopyralid	Picloram (100g/L) + Triclopyr (300g/L) + Aminopyralid (8g/L)	3.5mL/L water + wetter	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	3.5mL/L water	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	17mL/L diesel	Cut stump/ Basal bark
		Picloram + Aminopyralid	Picloram (44.7g/L) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump
Prosopis juliflora (Sw.) DC.	Fabaceae	Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Senna alata (L.) Roxb.	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna hirsuta (L.) H.S.Irwin & Barneby	Fabaceae	See other *Senna* spp.			
Senna obtusifolia (L.) H.S. Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar

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Senna occidentalis (L.) Link	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
Senna septemtrionalis (Viv.) H.S.Irwin & Barneby	Fabaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.9g + 0.225g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g/L + 0.35g/L + 0.028g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (200g/L)	5-10mL/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	3-6mL/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1–0.2g/L water + surfactant	Foliar
		Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	111mL/Lwater	Foliar – splatter gun
		Glyphosate	Glyphosate (360g/L)	50mL/Lwater	Wipe onto leaves
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	10g/L water + surfactant	Wipe onto leaves
		Fluroxypyr	Fluroxypyr (200g/L)	35mL/L diesel/ kerosene	Basal bark
		Fluroxypyr	Fluroxypyr (333g/L)	21mL/L diesel/ kerosene	Basal bark
Myriophyllum aquaticum (Vell.) Verdc.	Haloragaceae	Flumioxazin	Flumioxazin (500g/L)	0.35g/L water + wetter	Foliar
Limnobium laevigatum (Humb. & Bonpl. ex Willd.) Heine	Hydrocharitaceae	Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	111mL/L water	Foliar – splatter gun
		Diquat 200g/L	Diquat (200g/L)	0.005mL/L water	Foliar/Stem injection
Hyptis suaveolens (L.) Poit.	Lamiaceae	2,4-D	2,4-D Amine (625g/L)	8.75g/L water	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.375g + 0.09g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	0.42g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.01g/L water + wetter	Foliar
		Triclopyr	Triclopyr (600g/L)	0.5g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L)+ Picloram (100g/L)	0.25g + 0.08g/L water + wetter	Foliar
Azadirachta indica A. Juss.	Meliaceae	Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Cut stump/ Basal bark
		Glyphosate	Glyphosate (360g/L)	180g/L water	Stem injection

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		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	50g + 25g + 6.25g/L water	Stem injection
Melia azedarach L.	Meliaceae	See *Azadirachta indica*			
Broussonetia papyrifera (L.) L'Hér. ex Vent.	Moraceae	Glyphosate	Glyphosate (360g/L)	180g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
		Triclopyr	Triclopyr (600g/L)	20g/L diesel	Basal bark
		Triclopyr + Picloram + Aminopyralid	Triclopyr (200g/L) + Picloram (100g/L) + Aminopyralid (25g/L)	50g + 25g + 6.25g/L water	Stem injection
Psidium guajava L.	Myrtaceae	Triclopyr	Triclopyr (600g/L)	300g/L diesel	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	8g + 4g/L diesel	Cut stump/ Basal bark
Nephrolepis cordifolia	Nephrolepidaceae	Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/kg)	20mL + 0.15g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1–0.2g/L water	Foliar
Mirabilis jalapa L.	Nyctaginaceae	Glyphosate	Glyphosate (360g/L)	1.6g/L water	Foliar
Ligustrum lucidum W.T. Aiton	Oleaceae	Metsulfuron-methyl + Aminopyralid	Metsulfuron-methyl (300g/kg) + Aminopyralid (375g/kg)	0.2g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	1 g/L + organosilicone penetrant	Foliar
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	33mL/L diesel	Cut stump/ Basal bark
		Triclopyr	Triclopyr (600g/L)	83mL/L diesel	Cut stump/ Basal bark
		Picloram + Aminopyralid	Picloram (44.7g/kg) + Aminopyralid (4.47g/L)	Neat: 3–5 mm layer	Cut stump/ Stem injection
		Glyphosate	Glyphosate (360g/L)	Neat: 1-2mL per cut)	Stem injection
Argemone mexicana L.	Papaveraceae	2,4-D	2,4-D (625g/L)	0.73g/L water	Foliar
		2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	0.25g + 0.06g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	0.45g/L water	Foliar
Argemone ochroleuca Sweet	Papaveraceae	See *Argemone mexicana*			
Passiflora edulis Sims	Passifloraceae	Glyphosate	Glyphosate (360g/L)	7.2g/L water	Foliar
Arundo donax L.	Poaceae	Glyphosate	Glyphosate (360g/L)	20mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Cut stump
Pontederia crassipes Mart.	Pontederiaceae	Amitrole + Ammonium Thiocyanate	Amitrole (250g/L) + Ammonium Thiocyanate (220g/L)	0.7g + 0.62g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	4.68g/L + wetter	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water	Foliar
Crataegus monogyna Jacq.*	Rosaceae	Glyphosate	Glyphosate (360g/L)	10-13mL/L water	Foliar

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		Glyphosate	Glyphosate (360g/L)	111mL/L water	Foliar – splatter gun
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.1g/L water	Foliar
		Triclopyr + Picloram	Triclopyr (300g/L) + Picloram (100g/L)	5mL/L water	Foliar
Crataegus mexicana Moc. & Sessé ex DC.	Rosaceae	See *Crataegus monogyna*			
Pyracantha spp.	Rosaceae	Fluroxypyr	Fluroxypyr (200g/L)	35mL/L diesel/ kerosene	Basal bark
		Fluroxypyr	Fluroxypyr (333g/L)	21mL/L diesel/ kerosene	Basal bark
		Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/kg)	1:1.5 glyphosate to water + 1 g metsulfuron to 1 L water	Stem injection
		Glyphosate	Glyphosate (360g/L)	667mL/L water	Cut stump/ Drill/Frill/Stem injection
Rubus niveus Thunb.	Rosaceae	Glyphosate	Glyphosate (360g/L)	20mL + 0.15g Metsulfuron-methyl/L water + wetter	Foliar
		Picloram + Aminopyralid	Picloram (44.7g/L) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump
Salvinia molesta D.S. Mitch.	Salvinaceae	Diquat	Diquat (200g/L)	1.67g/L water	Foliar
		Flumioxazin	Flumioxazin (500g/L)	0.35g/L water	Foliar
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.06g/L water + wetter	Foliar
		Orange oil	Orange oil 55.2g/kg	10mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L) Only products registered for aquatic use	10mL/L water	Foliar
		Glyphosate	Glyphosate (360g/L) Only products registered for aquatic use	10mL/L water	Foliar
Cardiospermum grandiflorum Sw	Sapindacaeae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate + Metsulfuron-methyl	Glyphosate (360g/L) + Metsulfuron-methyl (600g/L)	20mL + 0.15g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	240g/L water	Cut stump
		Picloram	Picloram (45g/kg)	Neat: 3-5 mm layer	Cut stump/ Stem injection
		Picloram + Aminopyralid	Picloram (44.7g/kg) + Aminopyralid (4.47g/L)	Neat: 3-5 mm layer	Cut stump/ Stem injection
Brugmansia suaveolens (Humb. & Bonpl. ex Willd.) Bercht. & J.Presl	Solanaceae	Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.05g + 0.35g + 0.028g/L water	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3 to 5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Cut stump/ Basal bark
Datura innoxia Mill.	Solanaceae	Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	2.7g/L water	Foliar
Datura stramonium L.	Solanaceae	2,4-D	2,4-D Amine (625g/L)	0.58g/L water	Foliar

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		Glyphosate	Glyphosate (360g/L)	2.7g/L water	Foliar
		Glyphosate	Glyphosate (450g/L)	4-5.6mL/L water	Foliar
		Glyphosate	Glyphosate (450g/L)	4-5.3mL/L water	Foliar
Nicotiana glauca Graham	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
Solanum chrysotrichum Schltdl.	Solanaceae	Glyphosate with Metsulfuron-methyl	Glyphosate (360g/L) with Metsulfuron-methyl (600g/kg)	20mL + 0.1g/L water + wetter	Foliar
		Picloram + Triclopyr + Aminopyralid	Picloram (100g/L) + Triclopyr (300g/L) + Aminopyralid (8g/L)	3.5-5mL/L water + wetter	Foliar
		Triclopyr + Picloram with Metsulfuron-methyl	Triclopyr (300g/L) + Picloram (100g/L) with Metsulfuron-methyl (600g/kg)	3.5-5mL + 10g/L water + wetter	Foliar
Solanum seaforthianum Andrews	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.0g/L water	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Solanum torvum Sw.	Solanaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g + 0.49g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	7.2g/L water + wetter	Foliar
		Imazapyr	Imazapyr (250g/L)	2.5g/L water	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	1.5g + 0.5g + 0.04g/L water	Foliar
		Imazapyr	Imazapyr (250g/L)	50.0g/L water	Cut stump
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g + 2g/L diesel	Cut stump/ Basal bark
Lantana camara L.	Verbenaceae	2,4-D + Picloram	2,4-D (300g/L) + Picloram (75g/L)	1.95g/L + 0.49g/L water + wetter	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	0.07g/L + 0.98g/L water + wetter	Foliar

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Species	Family	Active constituent	Active constituent with concentration	A.I. (grams) per Litre	Method of application
		Fluroxypyr	Fluroxypyr (200g/L)	2.0g/L water + wetter	Foliar
		Glyphosate	Glyphosate (360g/L)	3.6g/L water + wetter	Foliar
		Triclopyr + Picloram + Aminopyralid	Triclopyr (300g/L) + Picloram (100g/L) + Aminopyralid (8g/L)	2.25g + 0.75g + 0.06g/L water + wetter	Foliar
		Aminopyralid + Fluroxypyr	Aminopyralid (10g/L) + Fluroxypyr (140g/L)	1.0g/L + 14.0g/L water + wetter	Foliar - Splatter gun
		Glyphosate	Glyphosate (360g/L)	36g/L water + wetter	Foliar - Splatter gun
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	1.2g/L water + wetter	Foliar - Splatter gun
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Triclopyr	Triclopyr (600g/L)	10g/L diesel	Cut stump/ Basal bark
		Triclopyr + Picloram	Triclopyr (240g/L) + Picloram (120g/L)	4g +2g/L diesel	Cut stump/ Basal bark
Stachytarpheta jamaicensis (L.) Vahl	Verbenaceae	2,4-D	2,4-D Amine (500g/L)	1.0g/L water	Foliar
		Fluroxypyr	Fluroxypyr (333g/L)	1.5g/L water	Foliar
Hedychium flavescens Carey ex Roscoe	Zingiberaceae	Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	0.15g/L + wetter	Foliar
		Picloram + Aminopyralid	Picloram (43g/kg) + Aminopyralid (4.3g/kg)	Neat: 3-5 mm layer	Cut stump
		Imazapyr	Imazapyr (250g/L)	125g/L water	Cut stump
		Metsulfuron-methyl	Metsulfuron-methyl (600g/kg)	3.6g/L + wetter	Cut stump

*Not known to be present in Malawi or Zambia – assumed that herbicides will also be effective against those congeners present in these countries

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Appendix D

Registered and minor-use* herbicides applied in South Africa for the control of some of the plant species included in this Field Guide with herbicide concentrations/volumes based on weed densities of closed stands (100% cover) [South Africa Department of Environment Affairs (DEA), Environmental Programmes (EP), Natural Resource Management (NRM), and XACT Information (2005)]. Please note that "lopping/pruning" and "cut and spray" applications use a similar methodology as that of "cut-stump," as explained elsewhere. Please read and adhere to product labels.

(Abbreviations used: cm = centimetre; EC = emulsifiable concentrate; g/kg = grams per kilogram; g/L = grams per litre; ha = hectare; kg = kilogram; L = litre; m = metre; m^2 = square metre; ME = micro-emulsion; mL = millilitre; mm = millimetre; SC = suspension concentrate; SL = solution; WG = water dispensable granule; WP = wettable powder)

Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Agave americana L. (Agavaceae)	MSMA 720g/L SL	All ages	10000		10	10	100	50	50	Stem inject
	Glyphosate (as sodium salt) 500g/kg WG	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480g/L SL	Young	200		0.2	10	2	6	300	Foliar spray
Agave sisalana Perrine (Agavaceae)	MSMA 720g/L SL	All ages	10000		10	10	100	50	50	Stem inject
			Use 2 mL concentrate per plant and inject into the sisal bole. Burn after plants have died and leaves have dried out.							
	Glyphosate (as sodium salt) 500g/kg WG	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480g/L SL		200		0.2	10	2	6	300	Foliar spray
Fucraea foetida (L.) Haw. (Agavaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Adult	2200		0.22	10	2.2	1.1	50	Stem inject
	MSMA 720g/L SL		200		2	100	2	10	500	Stem inject
Ageratum conyzoides (L.) L. (Asteraceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Glyphosate (as isopropylamine salt) 480g/L SL		150		0.15	10	1.5	4.5	300	Foliar spray
Tithonia diversifolia (Hemsl.) A. Gray (Asteraceae)	Fluroxypyr 80 + Picloram 80 g/L ME	All ages	75		0.075	10				Foliar spray
			Use 75 mL/10 L water + 50 mL mineral oil. Apply to the point of run-off.							
	Picloram 240 g/L SL		50-75		0.05-0.075	10				Foliar spray
			Use 50-75 mL/10 L water + 80 mL MCPA. Apply lower rate to small plants.							
Xanthium strumarium L. (Asteraceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP		17.5	0.10%	0.0175	10	0.175	0.525	300	Foliar spray

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Anredera cordifolia (Ten.) Steenis (Basselaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	100	0.10%	0.1	10	1	4	400	Foliar spray
	Fluroxypyr 80 + Picloram 80 g/L ME		50	0.10%	0.05	10	0.5	2	400	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240g/L EC		100	0.10%	0.1	10	1	4	400	Foliar spray
			Use 100 mL/10 L water. Apply as a full cover spray.							
	Triclopyr (as butoxy ethyl ester) 480g/L EC		50	0.10%	0.05	10	0.5	2	400	Foliar spray
			Use 50 mL/10 L water. Apply as a full cover spray.							
	Triclopyr (as butoxy ethyl ester) 480g/L EC	Adult	100	0.10%	0.1	10	1	2	200	Cut and spray
	Triclopyr (as butoxy ethyl ester) 480g/L EC		100		0.1	10	1	2	200	Basal bark + diesel
Dolichandra unguis-cati (L.) L.G.Lohmann (Bignoniaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	250	0.10%	0.25	10	2.5	7.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 360g/L SL	Adult	2		0.002	10	0.02	0.04	200	Cut and spray
	Imazapyr 100 g/L SL		800	0.10%	0.8	10	8	16	200	Cut and spray
Jacaranda mimosifolia D.Don (Bignoniaceae)	Imazapyr 100 g/L SL	Young	1000		1	10	10	20	200	Lopping/ pruning
	Imazapyr 100 g/L SL	Adult	1000		1	10	10	20	200	Cut stump/ frill
			Use 1 L/10 L water. Apply to the cut surface of freshly cut stumps. Use at least 10 mL per 10 cm of stump diameter.							
Opuntia ficus-indica (L.) Mill. (Cactaceae)	Glyphosate (as ammonium salt) 680g/kg WG	All ages	1800	0.10%	1.8	10	18	9	50	Stem inject
			Use 1.8 kg/10 L water. Inject 2 mL in pre-made holes in the stem of the plant (4 – 12 pre-made holes for plants with 20 – 250 cladodes).							
	Glyphosate (as isopropylamine salt) 360g/L SL		3300	0.10%	3.3	10	33	16.5	50	Stem inject
			Use 3.3 L/10 L water. Apply 2 mL into each of 4 – 12 pre-made holes in the stem of plants with 20 – 250 cladodes.							
	Glyphosate (as potassium salt) 450g/L SL		1800	0.10%	1.8	10	18	9	50	Stem inject
	Glyphosate (as potassium salt) 500 SL		2200	0.10%	2.2	10	22	11	50	Stem inject
			Use 2.2 L/10 L water. For plants with 20 – 250 cladodes drill 4 – 12 holes in stem and inject 3 mL/hole.							
Lonicera japonica Thunb. (Caprifoliaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	250	0.10%	0.25	10	2.5	7.5	300	Foliar spray

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Ipomoea alba L. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360g/L SL*	Young	200		0.2	10	2	6	300	Foliar spray
Ipomoea carnea Jacq. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 480g/L SL*	All	200	0.10%	0.2	10	2	6	300	Spray from boat/ shoreline
Ipomoea indica (Burm.) Merr. (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360g/L SL*	Young	200		0.2	10	2	6	300	Foliar spray
Ipomoea purpurea (L.) Roth (Convolvulaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	200		0.2	10	2	6	300	Foliar spray
	Glyphosate (as phosponic acid) 480g/L SL		220		0.22	10	2.2	6.6	300	Foliar spray
	Glyphosate (as potassium salt) 500 SL		130		0.13	10	1.3	3.9	300	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All ages	150		0.15	10	1.5	22.5	1500	Soil
Pteridium aquilinum (L.) Kuhn (Dennstaedtiaceae) – this is a native species	Imazapyr 100 g/L SL	All ages	63		0.063	10	6.3			Foliar spray
			Use 63 mL/10 L water. Apply to actively growing plants.							
	Imazapyr 240 g/L SL		25		0.025	10	2.5			Foliar spray
			Use 25 mL/10 L water. Apply to actively growing plants.							
	Metsulfuron-methyl 500g/ kg WP		2.4		0.0024	10	0.24			Foliar spray
			Use 2.4 g plus 50 mL mineral oil/10 L water. Apply to actively growing plants at the end of summer.							
	Metsulfuron-methyl 600g/ kg WG		2		0.002	10	0.2			Foliar spray
			Use 2 g plus 10 mL adjuvant/10 L water. Apply during growing period.							
Ricinus communis L. (Euphorbiaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	2000	0.50%	2	10	20	40	200	Cut and spray
			Use 200 mL + 50 mL mineral oil/10 L water. Apply to the surface of low cut stumps within three hours of felling.							
	Fluroxypyr 80 + Picloram 80 g/L ME		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 mL + 50 mL mineral oil/10 L water. Apply to cut surface of low cut stumps within three hours of felling.							
	Imazapyr 100 g/L SL		300		0.3	10	3	6	200	Cut and spray
			Use 300 mL/10 L water. Apply to freshly cut stumps. Apply at least 10 mL per 10 cm of stump diameter.							

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Acacia mearnsii De Wild. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Seedling	40	0.50%	0.04	10	0.4	1.2	300	Foliar spray
			Use 30-50 mL + 50 mL mineral oil/10 mL water. Apply the lower rate on seedlings and the higher rate on saplings as a full cover spray.							
	Fluroxypyr 200 g/L EC		12.5	0.50%	0.0125	10	0.125	0.375	300	Foliar spray
			Use 12.5 mL + 50 mL of mineral oil/10 L water. Apply as a full cover spray on young, actively growing plants up to 1 m high.							
	Glyphosate (as ammonium salt) 680g/kg WG		80	0.50%	0.08	10	0.8	2.4	300	Foliar spray
			Use 80 g/10 L water. Apply to plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 360g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 mL/10 L water. Apply in summer to plants up to 1 m high.							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
			Use 120 mL/10 L water. Spray plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 480g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 mL/10 L of water. Spray plants up to 1 m high.							
	Glyphosate (as sodium salt) 500g/kg WG		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 100 g/10 L water to young trees up to 1 m high.							
	Triclopyr (as butoxy ethyl ester) 240g/L EC		50	0.10%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50-150 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray to actively growing plants. Use lower rate on seedlings (smaller than 50 cm high) and higher rate on saplings.							
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480g/L EC		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
			Use 25 – 75 mL+ 50 mL mineral oil/10 L water. Apply as a full cover spray to actively growing plants. Use lower rate on seedlings (smaller than 50 cm high) and higher rate on saplings.							
	Triclopyr (as butoxy ethyl ester) 240g/L + Aminopyralid 30g/L		25	0.50%	0.025	10	0.25	0.75	300	Foliar spray
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Fluroxypyr 80 + Picloram 80 g/L ME		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray on actively growing plants.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 mL/10 L water. Apply in summer to young trees 1-2 m high.							
	Triclopyr (as butoxy ethyl ester) 240g/L EC		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 480g/L EC		75	0.10%	0.075	10	0.75	2.25	300	Foliar spray
	Fluroxypyr 80 + Picloram 80 g/L ME	Young	200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Imazapyr 100 g/L SL		1000		1	10	10	20	200	Lopping/ pruning
	Picloram (as potassium salt) 240g/L SL		150	0.50%	0.15	10	1.5	3	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Lopping/ pruning
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		200	0.50%	0.2	10	2	4	200	Lopping/ pruning
	Fluroxypyr 80 + Picloram 80 g/L ME	Adult	200	0.50%	0.2	10	2	4	200	Cut stump/ frill
	Imazapyr 100 g/L SL		1000		1	10	10	20	200	Cut stump/ frill
			Use 1 L/10 L of water. Apply to freshly cut stumps. Apply at least 10 mL per 100 mm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		150	0.50%	0.15	10	1.5	3	200	Cut stump/ frill
			Use 600 mL + 200 mL mineral oil/10 mL water. Apply sufficient mixture to fill the frill.							
	Triclopyr (as amine salt) 360 g/L SL		300	0.50%	0.3	10	3	6	200	Cut stump/ frill
			Use 300 mL + 50 mL mineral oil/10 L water. Apply to the cut surface of low cut stumps.							
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		200	0.50%	0.2	10	2	4	200	Cut stump/ frill
	Cylindrobasidium laeve		1 sachet / 400mL sunflower oil					200		Cut stump/ frill
	Picloram (as potassium salt) 240g/L SL		600	2.00%	0.6	10	6	12	200	Frill
			Use 150 mL + 50 mL mineral oil/10 L water. Apply to the cut surface of low cut stumps within 3 hours of felling.							

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Triclopyr (as butoxy ethyl ester) 480g/L EC		200		0.2	10	2	4	200	Basal stem + diesel
			Use 200 mL/10 L of diesel for plants with a stem diameter of up to 10 cm. Ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							
Acacia melanoxylon R.Br. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Seedling	70	0.50%	0.07	10	0.7	2.1	300	Foliar spray
			Use 70 mL + 50 mL mineral oil/10 L water. Apply to young actively growing saplings up to 2 m high.							
	Fluroxypyr 200 g/L EC		12.5	0.10%	0.0125	10	0.125	0.375	300	Foliar spray
			Use 12.5 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray to young actively growing plants up to 1 m high.							
	Triclopyr (as butoxy ethyl ester) 480g/L EC		75	0.50%	0.075	10	0.75	2.25	300	Foliar spray
			Use 75 mL + 50 mL mineral oil/10 L water. Apply to young actively growing plants up to 2 m high.							
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		100	0.50%	0.1	10	1	3	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240g/L + Aminopyralid 30g/L		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 150 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray to young actively growing trees up to 2 m high.							
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		600	0.50%	0.6	10	6	12	200	Lopping/ pruning
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	400	0.50%	0.4	10	4	8	200	Cut stump/ frill
			Use 400 mL + 50 mL mineral oil/10 L water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as amine salt) 360 g/L SL		600	0.50%	0.6	10	6	12	200	Cut stump/ frill
			Use 600 mL + 50 mL mineral oil/10 L water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		400	0.50%	0.4	10	4	8	200	Cut stump/ frill

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Triclopyr (as butoxy ethyl ester) 480g/L EC		200		0.2	10	2	4	200	Basal stem + diesel
			Use 200 mL/10 L diesel for plants with a stem diameter of up to 10 cm. Ensure wetting of the root crown, exposed roots and stem up to a height of 25 cm.							
Caesalpinia decapetala (Roth) Alston (Fabaceae)	Glyphosate (as ammonium salt) 680g/kg WG	Young	80	0.10%	0.08	10	0.8	2.4	300	Foliar spray
			Use 10 g/10 L water. Apply to plants up to 1 m high.							
	Glyphosate (as isopropylamine salt) 360g/L SL		150	0.10%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 mL/10 L water. Apply to plants up to 1 m high.							
	Glyphosate (as potassium salt) 450g/L SL		120	0.10%	0.12	10	1.2	3.6	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480g/L SL		110	0.10%	0.11	10	1.1	3.3	300	Foliar spray
			Use 110 mL/10 L water. Apply to plants up to 1 m high.							
	Glyphosate (as potassium salt) 500 SL		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 mL/10 L water. Apply in summer.							
	Glyphosate (as sodium salt) 500g/kg WG		110	0.50%	0.11	10	1.1	3.3	300	Foliar spray
	Triclopyr (as butoxy ethyl ester) 240g/L EC		100	0.10%	0.1	10	1	3	300	Foliar spray
			Use 100 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray to actively growing plants up to 3 m high. Taller plants must be cut back and regrowth treated.							
	Triclopyr (as butoxy ethyl ester) 480g/L EC		50	0.50%	0.05	10	0.5	1.5	300	Foliar spray
			Use 50 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray to actively growing plants up to 3 m high. Taller plants must be cut back and regrowth treated.							
	Triclopyr (as amine salt) 360 g/L SL	Adult	300	0.10%	0.3	10	3	6	200	Cut and spray
Leucaena leucocephala (Lam.) de Wit (Fabaceae)	Triclopyr (as butoxy ethyl ester) 480g/L EC*	Young	100		0.1	10	1	2	200	Basal stem + diesel
	Triclopyr (as butoxy ethyl ester) 480g/L EC	Adult	100		0.1	10	1	2	200	Basal stem + diesel
Mimosa pigra L. (Fabaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	300		0.3	10	3	9	300	Foliar spray
			Use 300 mL/10 L water with knapsack sprayer or 400 mL/10 L water with mistblower. Apply as a full cover spray in summer to autumn.							
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	6.6	300	Foliar spray
	Glyphosate (as sodium salt) 700g/kg WG		157		0.157	10	1.57	4.71	300	Foliar spray

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Senna didymobotrya (Fresen.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Senna hirsuta (L.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Senna occidentalis (L.) Link (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Senna septemtrionalis (Viv.) H.S. Irwin & Barneby (Fabaceae)	Imazapyr 100 g/L SL*	Adult	500		0.5	10	5	10	200	Cut and spray
Prosopis glandulosa Torr. (Fabaceae)	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Young	150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 100-150 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray. Plants too tall should be slashed and regrowth sprayed.							
	Glyphosate (as potassium salt) 500 SL		500	0.10%	0.5	10	5	15	300	Foliar spray
			Use 350-660 mL/10 L water. Apply to seedlings and regrowth.							
	Triclopyr (as triethyl ammonium) 120g/L + Aminopyralid 12g/L		300	0.50%	0.3	10	3	9	300	Foliar spray
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL	Adult	400	0.50%	0.4	10	4	8	200	Lopping/ pruning
	Triclopyr (as butoxy ethyl ester) 240g/L EC		800	0.10%	0.8	10	8	16	200	Lopping/ pruning
	Triclopyr (as amine salt) 360 g/L SL		500	2.00%	0.5	10	5	10	200	Lopping/ pruning
	Clopyralid 90 + Triclopyr (as amine salt) 270 g/L SL		400	0.50%	0.4	10	4	8	200	Cut stump/ frill
			Use 400 mL + 50 mL mineral oil/10 L water. Apply to cut surface of low cut stumps within 3 hours of felling.							
	Triclopyr (as butoxy ethyl ester) 240g/L EC		800	0.10%	0.8	10	8	16	200	Cut stump/ frill
			Use 800 mL/10 L diesel. Apply to the cut surface and all bark and root crown of low cut stumps.							
	Triclopyr (as amine salt) 360 g/L SL		500	2.00%	0.5	10	5	10	200	Cut stump/ frill
			Use 500 mL + 200 mL mineral oil/10 L water. Apply to the cut surface of low cut stumps within three hours of felling.							
	Picloram (as potassium salt) 54g/kg + Triclopyr (as triethylamine) 36g/kg		Paint directly onto stumps 10g/10mm stump			200				Cut stump/ frill

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
	Triclopyr (as butoxy ethyl ester) 480g/L EC		400	0.50%	0.4	10	4	8	200	Cut stump/ frill
	Glyphosate (as potassium salt) 500 SL	All ages	500	0.50%	0.5	10	5	20	400	Aerial application
Myriophyllum aquaticum (Vell.) Verdc. (Haloragaceae)	Diquat dibromide (as dibromide salt) 200g/L SL	All ages	7500	0.10%	7.5	10	75	37.5	50	Spray from boat/ shoreline
	Glyphosate (as isopropylamine salt) 480g/L SL		300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as sodium salt) 500g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as sodium salt) 700g/kg WG		200	0.10%	0.2	10	2	6	300	Spray from boat/ shoreline
Melia azedarach L. (Meliaceae)	Fluroxypyr 320g/L + Triclopyr 160 g/L EC	Seedlings	33		0.033	10				Foliar spray
			Use 50 mL/10 L water. Add an adjuvant at the rate of 50 mL/10 L water. Apply to actively growing plants.							
	Clopyralid 90g/L + Triclopyr 270 g/L SL	Adult	300		0.3	10				Cut stump
			Use 300 mL/10 L water + 50 mL mineral oil. Fill the frill without unnecessary run-off down stem.							Frill
	Fluroxypyr 80 + Picloram 80 g/L ME		150		0.15	10				Cut stump
			Use 150 mL/10 L water + 50 mL mineral oil. Apply to low cut stumps.							
			200		0.2	10				Frill
			Use 200 mL/10 L water + 500 mL mineral water. Fill the frill without unnecessary run-off down stem.							
	Imazapyr 100 g/L SL		300		0.3	10				Cut stump
			Use 300 mL/10 L water. Apply to cut stump using a low-pressure applicator at not less than 10 mL/100 mm of stem diameter.							
	Imazapyr 240 g/L SL		125		0.125	10				Cut stump
			Use 125 mL/10 L water. Apply not less than 10 mL/100 mm diameter of stump.							
	Picloram 240 g/L SL		200		0.2	10				Cut stump
			Use 200 mL/10 L water + 50 mL mineral oil. Apply to low cut stumps.							
	Picloram 50 + Triclopyr 50g/ kg AL		Apply 1 mm undiluted gel directly onto the cut stumps using a brush.							Cut stump
	Triclopyr 360 g/L SL		300		0.3	10				Cut stump/ frill
			Use 300 mL/10 L water + 50 mL mineral oil. Apply to low cut stumps and fill the frills without unnecessary run-off down stem.							
	Triclopyr 480 g/L EC		200		0.2	10				Basal bark + diesel

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Eucalyptus camaldulensis Dehnh. (Myrtaceae) – may also be suitable for other *Eucalyptus* spp. – read product label.	Fluroxypyr 80 + Picloram 80 g/L ME	Young	450	0.50%	0.45	10	4.5	9	200	Lopping/ pruning
	Fluroxypyr 80 + Picloram 80 g/L ME	Adult	450	0.50%	0.45	10	4.5	9	200	Cut stump/ frill
Psidium guajava L. (Myrtaceae)	Fluroxypyr 80 + Picloram 80 g/L ME	Seedling	150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray on actively growing plants.							
	Imazapyr 100 g/L SL	Young	1250		1.25	10	12.5	25	200	Lopping/ pruning
	Imazapyr 100 g/L SL	Adult	1250		1.25	10	12.5	25	200	Cut stump/ frill
			Use 1.25 L/10 L water. Apply to the cut surface of low cut stumps. Apply at least 10 mL/100 mm of stump diameter.							
Nephrolepis cordifolia (L.) Presl (Nephrolepidaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	300	0.1%	0.3	10	3	12	400	Foliar spray
Mirabilis jalapa L. (Nyctaginaceae)	Glyphosate (as sodium salt) 500g/kg WG*	Young	220		0.22	10	2.2	6.6	300	Foliar spray
Argemone mexicana L. (Papaveraceae)	Glyphosate (as isopropylamine salt) 180g/L SL	Young	150		0.15	10	1.5	6	400	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	8.8	400	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All ages	600		0.6	10	6	90	1500	Soil
Argemone ochroleuca Sweet (Papaveraceae)	Glyphosate (as isopropylamine salt) 180g/L SL	Young	150		0.15	10	1.5	6	400	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	8.8	400	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC*	All ages	600		0.6	10	6	90	1500	Soil
Passiflora edulis Sims (Passifloraceae)	Glyphosate (as isopropylamine salt) 360g/L SL*	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray
Arundo donax L. (Poaceae)	Glyphosate (as sodium salt) 500g/kg WG	Adult	300		0.3	10	3	9	300	Foliar spray
	Glyphosate (as sodium salt) 700g/kg WG		215	0.10%	0.215	10	2.15	6.45	300	Foliar spray
Pennisetum setaceum (Forssk.) Chiov. (Poaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Young	150	0.10%	0.15	10	1.5	6	400	Foliar spray

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Species	Active constituent with concentration	Age	Dosage (mL/g)	Wetter/ dye	A.I, (L/ kg)	Mix (L)	% mix	Estimated product (L/ha or kg/ha)	Vol. of mix	Method of application
Pontederia cordata L. (Pontederiaceae)	Glyphosate (as isopropylamine salt) 480g/L SL	All ages	300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as sodium salt) 500g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as sodium salt) 700g/kg WG		200	0.10%	0.2	10	2	6	300	Spray from boat/ shoreline
Pontederia crassipes Mart. (Pontederiaceae)	Glyphosate (as sodium salt) 700g/kg WG	All ages	220	0.50%	0.22	10	2.2	6.6	300	Spray from boat/ shoreline
	Glyphosate (as isopropylamine salt) 480g/L SL		220	0.10%	0.22	10	2.2	6.6	300	Spray from boat/ shoreline
			Use 220mL/10 L water with a pressurized or knapsack sprayer and 300 mL/10 L with a mistblower. Apply when maximum exposure of leaves is visible.							
	Glyphosate (as sodium salt) 500g/kg WG		220		0.22	10	2.2	6.6	300	Spray from boat/ shoreline
	Glyphosate (as potassium salt) 500 SL		450		0.45	10	4.5	13.5	300	Spray from boat/ shoreline
			Use 200-265 mL/10 L water. Apply in summer on actively growing plants.							
	Glyphosate (as phosponic acid) 480g/L SL		225		0.225	10	2.25	6.75	300	Spray from boat/ shoreline
	Diquat dibromide (as dibromide salt) 200g/L SL		500		0.5	10	5	2.5	50	Aerial
			Use 7.5-10 L + 1.5 L wetting agent – 40 L water/ha. Apply on actively growing plants.							
	Glyphosate (as potassium salt) 500 SL		450		0.45	10	4.5	4.5	100	Aerial
			Use 4-5.3 L/30 L water/ha. Apply in summer on actively growing plants.							
Rubus niveus Thunb (Rosaceae)	Glyphosate (as phosponic acid) 480g/L SL	Young	450	0.10%	0.45	10	4.5	13.5	300	Foliar spray
	Glyphosate (as isopropylamine salt) 360g/L SL		300	0.10%	0.3	10	3	9	300	Foliar spray
			Use 300 mL/10 L water. Slash rank growth in winter and apply when growth is 0.5 m high.							
	Glyphosate (as sodium salt) 500g/kg WG		215	0.50%	0.215	10	2.15	6.45	300	Foliar spray
Salvinia molesta D.S. Mitch. (Salvinaceae)	Glyphosate (as sodium salt) 500g/kg WG	All ages	300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as sodium salt) 700g/kg WG		300	0.10%	0.3	10	3	9	300	Spray from boat/ shoreline
	Glyphosate (as isopropylamine salt) 480g/L SL		200	0.10%	0.2	10	2	6	300	Spray from boat/ shoreline
	Diquat dibromide (as dibromide salt) 200g/L SL		500	0.10%	0.5	10	5	2.5	50	Aerial
			Use 7.5 – 10 L + 1.5 L Agral 90/ha. Apply in 35 – 40 L water/ha.							

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Cardiospermum grandiflorum Sw (Sapindaceae)	Glyphosate (as isopropylamine salt) 360g/L SL	Adult	150	0.10%	0.15	10	1.5	3	200	Cut and spray
Datura innoxia Mill. (Solanaceae)	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP*	Young	17.5	0.10%	0.0175	10	0.175	0.35	200	Foliar spray
Datura stramonium L. (Solanaceae)	2.4D (as dimethylamine salt) 480g/L SL	Young	150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP		17.5	0.10%	0.0175	10	0.175	0.35	200	Foliar spray
	Glyphosate (as sodium salt) 500g/kg WG		110		0.11	10	1.1	2.2	200	Foliar spray
	Glyphosate (as isopropylamine salt) 180g/L SL		150		0.15	10	1.5	3	200	Foliar spray
	Tebuthiuron 250g/L + Bromacil 250g/L SC	All ages	150		0.15	10	1.5	3	200	Soil
Nicandra physalodes (L.) Gaertn. (Solanaceae)	Glyphosate (as isopropylamine salt) 480g/L SL	Young	150		0.15	10	1.5	4.5	300	Foliar spray
	2.4D (as dimethylamine salt) 480g/L SL		150	0.10%	0.15	10	1.5	2.25	150	Foliar spray
	Chlorimuron ethyl (as sulfonyl urea) 500g/kg WP		17.5	0.10%	0.0175	10	0.175	0.525	300	Foliar spray
Nicotiana glauca Graham (Solanaceae)	Glyphosate (as isopropylamine salt) 360g/L SL*	Young	300	0.10%	0.3	10	3	12	400	Foliar spray
Solanum seaforthianum Andrews (Solanaceae)	Triclopyr (as butoxy ethyl ester) 480g/L EC*	Young	50		0.05	10	0.5	1.5	300	Foliar spray
Lantana camara L. (Verbenaceae)	Fluroxypyr 80 + Picloram 80 g/L ME	Young	150	0.50%	0.15	10	1.5	4.5	300	Foliar spray
			Use 150 mL + 50 mL mineral oil/10 L water. Apply as a full cover spray on actively growing plants.							
	Glyphosate (as ammonium salt) 680g/kg WG		160	0.10%	0.16	10	1.6	4.8	300	Foliar spray
			Use 160 g/10 L water with knapsack sprayer or 200 g/10 L water with mistblower. Apply as a full cover spray.							
	Glyphosate (as isopropylamine salt) 360g/L SL		300	0.10%	0.3	10	3	9	300	Foliar spray
			Use 300 mL/10 L water with knapsack sprayer or 400 mL/10 L water with mistblower. Apply as a full cover spray in summer to autumn.							
	Glyphosate (as potassium salt) 450g/L SL		240	0.10%	0.24	10	2.4	7.2	300	Foliar spray
	Glyphosate (as isopropylamine salt) 480g/L SL		220	0.10%	0.22	10	2.2	6.6	300	Foliar spray
			Use 220 mL/10 L water with knapsack sprayer and 300 mL/10 L with a mistblower.							

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	Glyphosate (as potassium salt) 500 SL		200	0.10%	0.2	10	2	6	300	Foliar spray
			Use 200 mL/10 L water. Slash large bushes in winter and apply to regrowth in summer.							
	Glyphosate (as sodium salt) 500g/kg WG		220	0.50%	0.22	10	2.2	6.6	300	Foliar spray
	Imazapyr 100 g/L SL		200		0.2	10	2	6	300	Foliar spray
			Use 200 mL/10 L water. Apply as a full cover spray when regrowth is 0.5 to 1 m high.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	3	300	Foliar spray
			Use 75–100 mL + 50 mL mineral oil/10 L water. For high volume application use 50 mL/10 L water and add a foaming agent. Apply as a full cover spray. Use higher rate for previously slashed plants with big stumps.							
	Fluroxypyr 80 + Picloram 80 g/L ME	Adult	150	0.50%	0.15	10	1.5	3	200	Cut and spray
			Use 150 mL + 50 mL mineral oil/10 L water. Apply to cut surface of low cut stumps within three hours of felling.							
	Imazapyr 100 g/L SL		200		0.2	10	2	4	200	Cut and spray
			Use 200 mL/10 L water. Apply to the cut surface of freshly cut stumps. Use at least 10 mL per 10 cm of stump diameter.							
	Picloram (as potassium salt) 240g/L SL		100	0.50%	0.1	10	1	2	200	Cut and spray
			Use 100 mL + 50 mL mineral oil/10 L water. Apply to the cut surface of low cut stumps within three hours of felling.							
Hedychium flavescens Carey ex Roscoe (Zingiberaceae)	Imazapyr 100 g/L SL*	Adult	200		0.2	10	2	4	200	Cut and spray

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Glossary

(verbatim from Environmental Weeds of Australia, 2016)

A

Achene: a small, dry, one-seeded fruit that does not open at maturity

Acute: pointed, having a sharp tip

Alien: occurring in, and/or naturalized in, a region to which it is not native or indigenous

Allelopathic: chemicals released by a plant that inhibit the growth of other plants

Alternately arranged: leaves arranged or held singly at each node

Annual: a plant which completes its life cycle within one year and then dies after flowering

Apex: the tip or end of a structure

Aquatic: living or growing in, near, or on water

Areole: a small light to dark coloured bump found on the modified stems of cacti (cladodes), out of which grow clusters of spines; used to identify species in the cactus family

Aril: a small fleshy appendage that is attached to a seed

Aromatic: having a distinctive smell or aroma

Ascending: growing on a slant at first, but becoming upright

Axil: the upper angle between a leaf stalk and the stem that bears it

Axillary: located or occurring in an axil

B

Basal: located at or near the base of a particular plant part

Berry: a fleshy fruit, without a hard centre, that does not open at maturity

Biennial: a plant that lives longer for one year but less than two years

Biodiversity: the number and variety of organisms found at a site or within a specified geographic region

Biological control: the use of natural enemies to reduce the damage caused by a weed or other pest population

Bipinnate: twice-divided; consisting of parts that are already compound

Blade: the expanded, usually flattened, part of a leaf or other plant structure

Bract: a small leaf-like structure usually found underlying another plant structure

Branchlet: a very small or very young branch; the smallest subdivision of a branch

Broadleaf: refers to a member of the group of plants known as the dicotyledons; having broad or relatively broad leaves

Bulb: a plant storage organ found below ground, which is usually surrounded and protected by dead leaf tissues

Bulbil: a small bulb that may be produced below ground, in the leaf axils, or in the seed-head

Bur: a structure consisting of the seeds or fruits of plants, usually surrounded by a prickly outer covering

C

Capsule: a dry fruit that opens at maturity, releasing its contents

Catkin: an elongated cluster of unisexual flowers that lack petals

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Cladode: a flattened stem which resembles, and functions as, a leaf

Climber: a vine or climbing plant that grows up over a supporting structure or other plants

Cone: the reproductive structure of certain non-flowering plants such as pine trees, consisting of a central axis around which are arranged a compact group of scales

Conical: cone-shaped; having a shape that tapers from a wide base to a point at the apex

Conifer: a gymnosperm that bears its reproductive structures in cones

Coppice: forming shoots or sprouts from a stump

Cordate: heart-shaped in outline

Corky: woody stems at least partially made up of a light, soft, water-resistant, protective tissue

Corm: an underground storage and propagative structure similar to a bulb, but formed from a swollen underground stem

Corrugated: shaped into folds; with parallel and alternating ridges and grooves

Cosmopolitan: widely distributed; occurring in many parts of the world or in many habitats

Creeper: a plant with a low-growing or creeping habit

Creeping: to grow or spread over the ground surface or over other ground-dwelling plants

Culm: the upright stem of a grass or similar plant; the flowering stem of a grass plant

Cuneate: wedge-shaped; triangular, but narrower at the base and wider at the tip

Cylindrical: cylinder-shaped; elongated and round in cross-section

D

Deciduous: describing a plant that sheds most or all of its leaves at the end of the growing season

Deflexed: bent backwards and downwards at a sharp angle

Dicotyledon: a flowering plant with two seed leaves or cotyledons that usually appear at germination

Digitate: having distinct parts or finger-like projections branching from a common point

Domatium: a small, rounded projection that is often located on or near the midrib of a leaf

Drupe: a fruit with a stony centre (which contains a single seed) surrounded by a fleshy layer and a skin that does not open at maturity

Drupelet: a small drupe; a segment of an aggregate fruit (e.g. blackberry)

E

Ellipsoid: shaped like an oval or ellipse, and solid or three-dimensional

Elongated: being significantly longer than wide

Emarginate: with a broad shallow notch at the tip

Endemic: native to a particular locality, region, state or country

Entire margin: a leaf margin that is uniform

Evergreen: having leaves throughout the year; not deciduous

Exotic: not native; from another part of the world

F

Fern: a plant that does not flower or produce seeds, is made up of roots, stems, and fronds and reproduces by spores

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Fibrous roots: roots that are small, thin, bunched, and resemble a group of fibres

Flower-head: another name for a head or capitulum; an inflorescence of densely packed small flowers that is mostly found in the daisy family

Follicle: a dry fruit which has one compartment and opens only along one side at maturity

G

Glabrous: hairless; without hairs or similar structures

Gland: a structure that is usually minute and globular which often secretes oily, resinous or gummy substances

Globular: rounded; shaped like a sphere, ball or globe

Glochids: barbed hairs or bristles

H

Habitat: a location where, or environment in which, an organism commonly grows

Head: a flower-head; an inflorescence of densely packed small flowers that is mainly found in the daisy family

Hispid: covered in short stiff hairs, rough hairs or bristles

I

Imparipinnate: a pinnate leaf with an odd number of leaflets (i.e. with a single terminal leaflet)

Indigenous: native; originating or occurring naturally in a region or environment; not introduced

Inflorescence: a term that describes the arrangement of flowers as a group or cluster on the flowering part of a plant; the seed-head

Internode: the part of the stem between two nodes or joints

J

Juvenile: not fully grown or developed

L

Lanceolate: lance-shaped, narrow and tapering to a point at the apex

Latex: a milky sap or juice that is exuded from plant parts when they are broken

Leaflet: part of a larger compound leaf that itself resembles a small leaf

Lenticel: a corky spot or pore on the stem or branch of a woody plant

Linear: long and narrow

Lobed: having deeply indented margins and forming sections that are not completely separated from one another

M

Mericarp: a dry single-seeded fruit that is derived from a carpel and splits off from the remains of the ovary at maturity

Midrib: the central and principle vein of a leaf; the midvein

Monocotyledon: any of the large group of flowering plants having a single cotyledon in the seed (e,g. grasses, sedges, orchids and lilies)

Monoculture: a population made up of a single species; a site or area totally dominated by a species to the exclusion of any other species

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N

Node: the joint on a stem from which other structures such as leaves arise

Nut: a one-seeded and hard-shelled fruit that does not open at maturity

O

Oblanceolate: lance-shaped (i.e. lanceolate), but with the pointed end at the base

Oblong: somewhat elongated (i.e. longer than broad) and with approximately parallel sides, but flattened or two-dimensional

Obovate: egg-shaped in outline, but with the narrower end at the base

Obovoid: egg-shaped and solid, but with the narrower end at the base

Obtuse: with a blunt or rounded tip

Oppositely arranged: arranged in pairs and arising from the same level along a plant stem

Orbicular: circular in shape

Origin: the place where the weed came from

Ornamental: a plant deliberately grown or cultivated for its beauty or decorative value

Ovate: egg-shaped and flat; broader and rounded at the base and tapering toward the end

Ovoid: egg-shaped and solid or three-dimensional

P

Palmate: a compound leaf divided into leaflets that radiate from one point and resemble the fingers of a hand

Panicle: an inflorescence or flower cluster that is divided into branches, each bearing several flowers

Pappus: a ring of hairs, bristles or scales found at the top of many fruit belonging to the daisy plant family

Parapinnate: once-compound but with an even number of leaflets

Peduncle: the stem or stalk that supports a solitary flower; or the main stalk that supports an inflorescence or flower cluster

Pendulous: hanging downwards or drooping

Perennial: a plant which requires more than two years to complete its life cycle; living far longer than two years

Petal: the part of a flower that is usually brightly coloured and forming the inner whorl of the perianth

Petiole: a leaf stalk; a stalk attaching the leaf blade to the stem

Phyllode: a flattened and expanded leaf stalk that takes on the appearance and function of a leaf blade; a leaf-like petiole

Pinna: one of the branchlets of a twice-compound (i.e. bipinnate) leaf on which the leaflets are borne; one of the leaflets of a once-compound (i.e. pinnate) leaf

Pinnate: a once-compound leaf having several leaflets arranged on each side of a stem or rachis

Plantlet: a small plant, often formed on the tips of leaves or creeping stems

Pod: a several-seeded dry fruit that splits open at maturity; the fruit of a leguminous plant; the fruit of a member of the pea plant family

Prickle: a small sharp outgrowth on the stem or leaf; a small thorn

Propagule: a structure that gives rise to a new plant (e.g. seed, spore, etc.)

Prostrate: growing or lying flat along the ground

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R

Raceme: an unbranched inflorescence with several flowers, each flower having a stalk or pedicel

Rachis: the main stem of a branched inflorescence (i.e. flower cluster); the main stem of a compound leaf

Reticulate: marked with a network of lines; with the pattern of a network; net-like

Rhizome: a horizontal, root-like stem usually found underground and often with short internodes

Ribbed: having ridges or raised features on the surface

Riparian: relating to or located on the banks of a river or stream; growing or located near waterways

Runner: a creeping or trailing stem that roots at the nodes and at intervals along its length forming new plants; a stolon

S

Savannah: an ecological community made up of grassland with scattered trees that is found in tropical and sub-tropical regions

Scale: a much-reduced leaf or a small leaf-like structure; a small, thin, and often disc-shaped structure that protects a flower bud or is present on a fruit

Scalloped: edged with a series of curved projections; crenate

Shizocarp: a dry indehiscent fruit that splits into one-seeded segments (i.e. mericarps) at maturity

Scrambler: a plant that grows over low obstacles, structures or other low-growing plants; a plant that climbs almost horizontally

Scrambling: growing over low obstacles, structures or low-growing plants; climbing almost horizontally

Seed: a propagative plant part, or propagule, produced in a flower; a ripened plant ovule, usually consisting of an embryo and endosperm covered with a seed coat, and often also with accessory structures

Semi-deciduous: partially deciduous; describes a plant that sheds some of its leaves at the end of the growing season

Sepal: a part of the calyx, or outer whorl of a flower, that is often green and leaf-like in appearance

Septum: a thin partition or wall that separates two cavities, especially one that separates the compartments of an ovary or fruit

Serrate: edged with sharp projections or teeth that are forward-pointing

Sessile: stalkless; without a stalk and attached directly at the base

Sheath: an almost tubular structure such as the base of a leaf that surrounds or clasps the stem

Shrub: a many-stemmed, woody plant or relatively low height; a bush

Spathulate: spoon-shaped; with a long, narrow, base and rounded tip

Specimen: an individual of a species; a representative sample

Spike: an unbranched inflorescence with stalkless (i.e. sessile) flowers arranged directly on the stem

Spikelet: a unit of the inflorescence in the grasses and sedges having one to many reduced flowers; a small flower spike

Sprawling: growing or spreading in different directions in a straggling or disorderly manner

Stamen: a male reproductive organ of a flower consisting of a pollen-bearing anther and its stalk

Sterile: incapable of producing seed, fruit or other reproductive propagules

Stolon: a creeping or trailing stem that grows above ground and roots at the nodes; a runner

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Sub-acute: almost acute; somewhat pointed

Sub-cordate: almost cordate; somewhat heart-shaped

Submerged: growing under the water surface; below the water surface; under water

Sub-obtuse: almost obtuse; somewhat rounded

Sub-opposite: almost oppositely arranged; almost paired

Sub-shrub: a small or low growing shrub

Subterranean: underground or below the soil surface

Succulent: describing a leaf or stem that is thick and fleshy or juicy in appearance and has water-storing capacity; a plant with juicy leaves or stems that is adapted to semi-arid conditions

Sucker: a shoot produced from below-ground (i.e. from the roots or base of the stem) that can give rise to a new plant

Synonym: an alternative, usually previously used, scientific name

T

Taproot: the main root of a plant which grows directly downwards to a considerable depth

Temperate: a climate that is mild (i.e. warm in summer and cool in winter); the geographic area between the tropics and the frigid zones

Tendril: a slender, usually twisting, structure found on the stems or leaves of some plants that aids climbing by clinging to its objects and thereby providing support

Terminal: growing or present at the end of a plant structure (e.g. branch, stalk, leaf, fruit, etc.)

Terrestrial: living or growing on land

Tomentose: densely covered with short matted hairs; densely covered with matted woolly hairs

Toxic: poisonous (i.e. capable of causing injury or death)

Tree: a woody plant of considerable size when fully grown and usually with a single main trunk in evidence

Trifoliate: describing a compound leaf with three leaflets

Tropical: a climate characterized by hot temperatures and high humidity; the climatic zone either side of the equator

Truncate: appearing to abruptly terminate as if cut off squarely at the tip or base

Tuber: a swollen underground stem that functions as a food storage organ or as a means of vegetative reproduction; a projection or swelling on a stem

Tubular: shaped like a tube or hollow cylinder

Twiner: a climbing plant that winds, twists or coils around objects or plants for support

V

Variegated: having different coloured markings (e.g. spots, blotches, streaks or patches)

Vine: a climbing or creeping plant that is weak-stemmed and supported by other objects

W

Whorl: three or more leaves or other appendages arranged around a stem at the same level, usually at a node

Wing: a thin or membranous extension that is attached to one of a variety of plant structures (e.g. seed, fruit, stem)

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