

1. BIOLOGICAL CONTROL OF ALIEN INVASIVE PLANTS

1.1 Weeds, alien plants and invasive plants

INDIGENOUS AND ALIEN PLANTS

Plants are indigenous to the region in which they originated and evolved. An indigenous (native) plant species is one that has occurred naturally in that region for thousands of years, and was not brought there by direct or indirect human action. A plant species in its region of origin (native range) usually has a large variety of natural enemies (predators, parasites and diseases) that have co-evolved (developed) with it and that keep its population numbers in check without eradicating it. Since all indigenous plants in an area have their own natural enemies, none of them has a competitive advantage over the others, and therefore they all live in a state of equilibrium with each other.

Certain plants have a native range that encompasses several countries, such as silver-leaf nightshade (*Solanum elaeagnifolium*), which is indigenous to parts of both North and South America. Other, more specialised species are indigenous to only one particular region. The

Cape Floral Kingdom (popularly known as Fynbos) consists of a distinctive combination of plant species that is limited to parts of the Western and Eastern Cape Provinces in South Africa, and some of the species are even restricted to much smaller areas, sometimes only a single valley, e.g. the marsh rose, *Orothamnus zeyheri*. Such an indigenous species that has a very limited distribution is said to be endemic to that area.

If a plant occurs in a region where it is not indigenous, it is referred to as an alien (exotic, foreign, introduced, non-native, non-indigenous) plant. Any plant that occurs artificially outside its known historical natural range, no matter how long ago it was introduced, is regarded as an alien. A plant indigenous to one part of a country but growing in another part of the same country can even be considered to be an alien plant there, e.g. a king protea (*Protea cynaroides*) growing in a Pretoria garden.

Most alien plants can survive in their adopted country only if they are cared for. However, a certain proportion of alien plants manage to thrive in the new country, to reproduce and to maintain populations without human help, and are then called naturalised plants. If such naturalised plants are also able to spread over considerable distances into new, undisturbed, natural areas and replace the indigenous vegetation, they are regarded as alien invasive plants, or invaders for short. (More about these on the next page.)

The majority of alien plants in our country were introduced intentionally, with some useful purpose in mind, e.g. as crops, timber species, dune binders, ornamentals or simply as curiosities. Many alien plants arrived inadvertently, e.g. as contaminants of grain or

fodder or adhering to animals, humans or vehicles.

PROBLEM PLANTS

The term "weed" is a subjective term that depends on the opinion or intentions of the person who uses it. Weeds are often defined as plants that grow where they are unwanted. This implies that a particular plant species, e.g. a guava tree (*Psidium guajava*), could be regarded as a valuable crop plant by a guava farmer, but the same species might be regarded as a weed if growing in a nature reserve in KwaZulu-Natal. Similarly, an indigenous plant, e.g. karee (*Rhus lancea*), might be regarded as a weed if it germinates in somebody's formal rose garden.

The term "weed" is a broad term that can be used to include highly diverse categories of undesirable plants. Weeds can be classified more accurately by using terms such as pioneer plants, alien invasive plants, transformers or bush encroachers to indicate how they behave. One could also indicate in which situation they cause problems by classifying

them as environmental, crop, pasture, forestry, riparian, aquatic weeds etc.

In South Africa, the term "declared weed" is a legal term referring to Category 1 plants in terms of regulation 15 of the Conservation of Agricultural Resources Act, 1983 (Act 43 of 1983). (In other countries these would be called noxious weeds.) This term does not refer to weeds in general, but to a specific group of plants that are so harmful to the country that legislation against them is justified. This legislation is discussed in leaflet 1.2 in this series.

Both indigenous and alien plants could become problematic. Bush encroachers are indigenous trees or shrubs that are usually in equilibrium with their environment, but become unnaturally abundant as a reaction to the deterioration of their environment. If the natural grass cover in savanna areas is thinned out through overgrazing, drought or injudicious fires, the fuel load of the area becomes too low to sustain fires hot enough to kill the excess seeds and seedlings of the indigenous woody species. As a result, an unnaturally large number of these seeds will now germinate and survive and, without sufficient competition by grasses, the trees and shrubs become the predominant plant species. Sweet thorn (*Acacia karroo*) and sickle bush (*Dichrostachys cinerea*) are two common bush encroachers. These woody species are not the cause of the problem, but merely one of the symptoms of poor land management. Likewise, the removal of the bush encroachers will not solve the problem unless the cause of the environmental degradation is addressed at the same time.

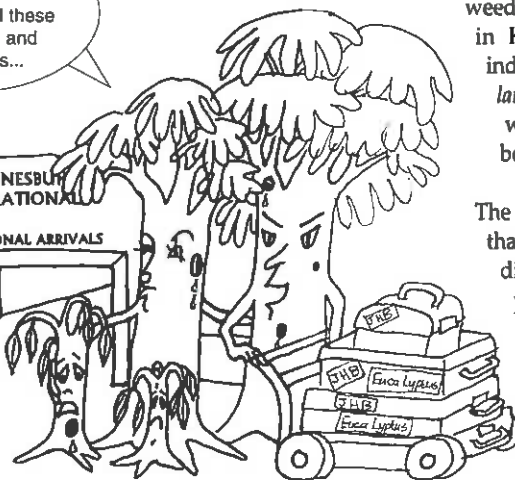
Most garden and crop weeds belong to a group of plants called pioneer plants. Pioneer plants can be either alien or indigenous

I want my seedlings to have a better, safer life, without all these leaf feeders and slemborers...

JOHANNESBURG INTERNATIONAL

INTERNATIONAL ARRIVALS

In their country of origin, plants are kept in check by natural enemies



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plants that are adapted to colonise denuded and disturbed areas. They are usually annual plants that complete their life cycle rapidly and produce large numbers of seeds in the short time available before other plant species arrive. However, they do not have a strong competitive ability and are therefore gradually replaced by plants higher up in the natural plant succession. Despite their nuisance value, pioneer plants are actually valuable components of an ecosystem in that they change a harsh environment into one more suited to plant life, and then gradually disappear. Pioneer plants include the well-known garden and roadside weeds such as blackjack (*Bidens pillosa*), khaki weed (*Tagetes minuta*), cocklebur (*Xanthium strumarium*) and thorn apples (*Datura stramonium*). As long as the area remains disturbed (e.g. by continuous cultivation) the pioneer plants will thrive there. If an area overrun by pioneer plants is, however, left alone and not disturbed any further, these pioneer plants will eventually be replaced by palatable grasses such as *Themeda triandra* and *Cenchrus ciliaris* or by other indigenous plants, depending on the climatic region. Like many natural processes, plant succession is a slow process and requires several years to reach this point.

Alien invasive plants are similar to pioneer plants in that they rapidly colonise disturbed areas, but differ from pioneer plants in having the additional ability to encroach upon undisturbed, pristine areas. They usually grow vigorously and disperse rapidly and, instead of being outcompeted by better-adapted plants, the invasive plants actively displace the indigenous vegetation and often transform the plant community. Several factors enable alien plants to become invaders, the most important of which is the absence of their natural enemies. For this reason, it is often possible to control alien invasive plant species by importing some of their host-specific natural enemies, thus removing their competitive advantage over the indigenous vegetation. This control method is called biological control (read more about it in leaflet 1.3 in this series).

Other characteristics that could enhance the invasiveness of an alien plant are strong vegetative growth, prolific seed production, long-lived seeds, a high seed germination rate, effective seed dispersal mechanisms, rapid maturation to a seed-producing stage and the ability to reproduce vegetatively (the ability of stems, leaves or roots to produce new plants). Plants that are imported into areas that have environmental conditions similar to those in their native country also have a better chance to become invasive there. Plants that can tolerate a large range of climatic and environmental conditions are also likely to become invasive.

In South Africa, "declared invader plant" is a legal term referring to Category 2 and 3 plants in terms of regulation 15 of the Conservation of Agricultural Resources Act (Act 43 of 1983). This term does not refer to all alien plants with invasive properties, but only to a specific group of them that are harmful enough to the country to justify legislation. This legislation is discussed in leaflet 1.2 in this series.

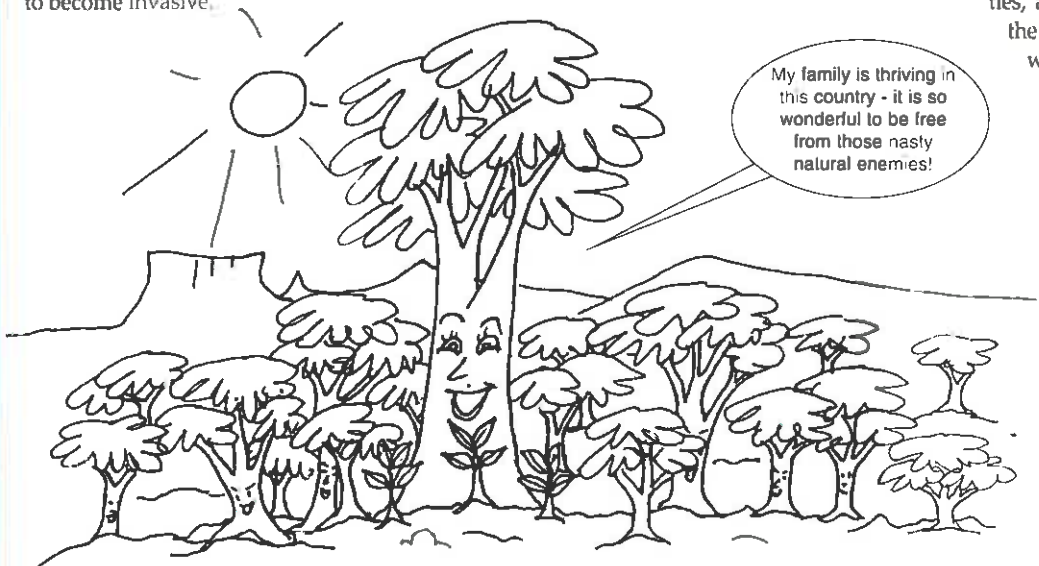
PROBLEMS CAUSED BY ALIEN, INVASIVE TERRESTRIAL PLANTS

Not all the alien plants are invasive. In fact, a large proportion of alien plants in South Africa consists of useful and even indispensable plants, e.g. crops and sources of fibre and timber. Unfortunately, many alien plants with valuable attributes have escaped from cultivation and are overwhelming and displacing the vegetation in almost all the climatic regions of the country. Some of the problems caused by alien plants, irrespective of whether they were introduced intentionally or inadvertently, are listed below.

- As a result of their greater size and density, alien plants that invade river courses and catchment areas usually use more water than the vegetation they are invading, e.g. certain wattles (Australian *Acacia* spp.), gum trees (*Eucalyptus* spp.), poplars (*Populus* spp.) and syringa (*Melia azedarach*). Invading alien trees cause a drastic reduction in the volume of water that reaches rivers and dams, and can even cause streams to stop flowing altogether.
- Dense stands of alien trees, such as the various Australian wattles and sesbania (*Sesbania punicea*), choke watercourses. Alien trees are easily ripped out during floods, often dislodging mats of indigenous vegetation and creating bare soil, which is prone to erosion. The dislodged trees often block the watercourses, causing further flood damage, or divert floodwater to areas sensitive to erosion.
- Most of the alien invasive plants in South Africa are large trees, which overtop the indigenous vegetation, depriving the plants of sunlight and thus causing them to decline. Alien plants are one of the most important causes of extinction of plants worldwide.
- By replacing the indigenous vegetation, alien plants reduce the biodiversity (the total of all species of living organisms occurring naturally in an area). The unique Cape Floral Kingdom (CFK), popularly known as fynbos, which has the highest species diversity in the world and therefore has incalculable conservation value, is particularly at risk. Alien plants, such as the pines, wattles, and *Hakea* spp., have already caused the extinction of several fynbos species, with numerous other species facing extinction.

• Alien plants belonging to the legume family (Fabaceae), e.g. the Australian wattles (*Acacia* spp.), change the composition of the soil by fixing nitrogen and making nitrates available to the soil. The indigenous fynbos plants are adapted to sandy, nitrogen-poor soils and many of them cannot survive in the enriched soils created under and around the wattle trees.

• Alien invasive plants spoil the beauty of our natural environment, and therefore reduce the region's potential economic value as a tourist attraction.



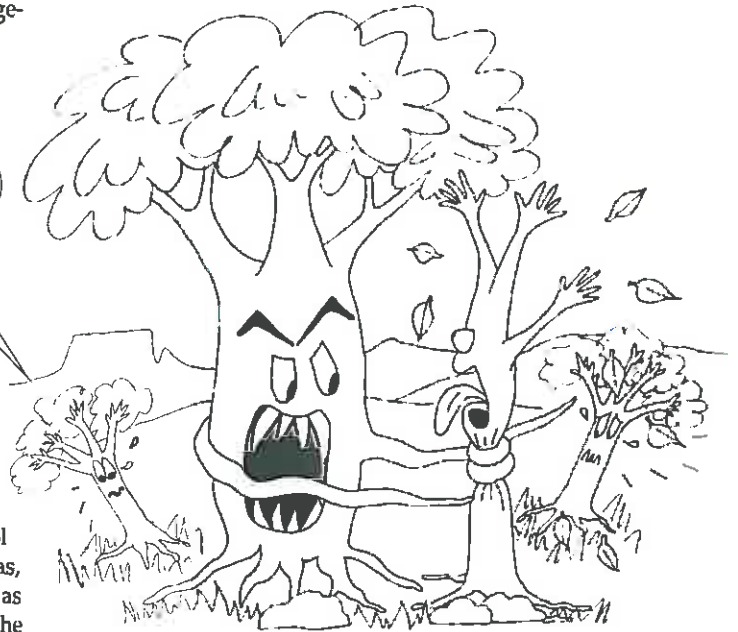
Alien plants could become invasive in the absence of their natural enemies.

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Monotonous stands of tall alien trees, such as wattles and gum trees, frequently obscure views of the original, species-rich vegetation and scenery, detracting from the tourists' experience of the country.

- Changes in plant composition also reduce the associated animal life of the area. Many of our indigenous birds, insects and other animals are not adapted to feed on or nest in alien plants. The larger the variety of plant species in an area, the more animal species it can usually support.
- In certain areas, such as the CFK, alien plants prevent the economic utilisation of natural products such as thatch, rooibos tea, honeybush tea and buchu.
- Alien plants interfere with agricultural activities by encroaching upon arable land, e.g. field bindweed (*Convolvulus arvensis*) and chromolaena (*Chromolaena odorata*), and upon pastures, e.g. pom-pom weed (*Campuloclinium macrocephalum*) and bramble (*Rubus cuneifolius*). Their control inflates the production costs drastically. In low production areas, such as the Northern Cape, the control of alien invaders such as mesquite (*Prosopis* spp.) often costs more than the value of the land itself.
- Thorny or spiny invaders, e.g. mesquite, bramble, Mauritius thorn (*Caesalpinia decapetala*) and several cacti (*Opuntia* spp., *Harrisia martinii*, *Cereus jamacaru* and *Pereskia aculeata*), form impenetrable thickets or barriers that prevent access to streams, pastures, shade trees or plantations.
- Several alien species, such as lantana, (*Lantana camara*) inkberry (*Cestrum* spp.), oleander (*Nerium oleander*), sesbania, syringa and silverleaf nightshade, are toxic to humans and/or livestock while others, such as jointed cactus (*Opuntia aurantiaca*), rosea cactus (*Opuntia fulgida*) and spiny cocklebur (*Xanthium spinosum*) attach themselves to the coat, feet or mouths of livestock, causing economic losses and a lot of suffering to the animals.
- A few alien invasive plants, such as bugweed (*Solanum mauritianum*), pampas grass (*Cortaderia jubata*) and parthenium weed (*Parthenium hysterophorus*), cause allergic reactions and other health problems in humans.
- Many alien species, e.g. nassella tussock (*Nassella trichotoma*), are unpalatable to livestock and progressively dominate pastures because the edible species are selectively grazed.
- In forestry situations, invasive plants such as lantana, Mauritius thorn and bugweed obstruct the access to trees and interfere with the activities of workers. Species with large leaves, e.g. bugweed, shade out the newly established seedlings. Invaders with edible fruits, especially bugweed, attract birds, which often perch on young forestry species, thus damaging their growth tips.

Help us!
The alien strangler
will kill us all!



Invasive alien plants replace the natural vegetation.

- Alien species, such as pines, the Australian *Acacia* species and chromolaena, are a fire hazard (thence the name "paraffin bush" for chromolaena). This could be either because they contain flammable compounds or because they have a higher fuel load than the vegetation they are replacing. Alien plants left lying around after clearing might also fuel rampant fires. Fires fuelled by alien plants are often hotter than normal fires. Such hot

fires sterilise the soil and kill the roots that keep soil particles together, thus resulting in soil erosion.

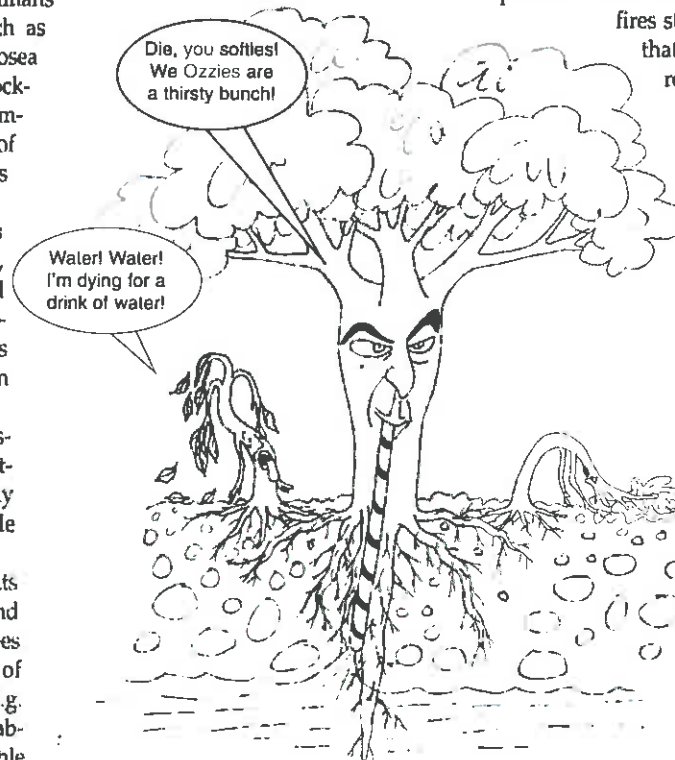
- Soil erosion is also caused by large, alien trees such as black wattle, which prevent the establishment of vegetation in their shade. Certain alien species also seem to secrete chemicals into the soil that prevent germination of other plant species in their vicinity.

- Certain alien species, such as bugweed, produce berries that are so attractive to birds that the birds do not feed on the fruits of indigenous plants any longer. The indigenous plants that rely on birds for the dispersal of their seeds might become locally extinct in such areas.

- Alien climbers, such as pereskia (*Pereskia aculeata*), cat's claw creeper (*Macfadyena unguis-cati*), Mauritius thorn and balloon vine (*Cardiospermum grandiflorum*), drape themselves around trees, weigh them down and could eventually cause them to collapse.

Die, you softies!
We Ozzies are
a thirsty bunch!

Water! Water!
I'm dying for a
drink of water!



Large alien trees use more water than the vegetation they are invading.

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PROBLEMS CAUSED BY ALIEN AQUATIC WEEDS

- Respiration at night by submerged weeds, such as parrot's feather (*Myriophyllum aquaticum*), can cause oxygen deficiencies in water.
- Floating aquatic weeds, such as water hyacinth (*Eichhornia crassipes*), salvinia (*Salvinia molesta*), water lettuce (*Pistia stratiotes*) and red water fern (*Azolla filiculoides*) form dense mats that block pump inlets, restrict the use of boats for fishing and river transport, reduce the flow of water in canals, cause siltation of rivers and increase water loss by evapotranspiration.
- Aquatic weeds provide breeding sites for mosquitoes and snails that carry diseases such as malaria and bilharzia.
- Cattle often drown when trying to walk over seemingly solid masses of aquatic weeds.
- The leaves of floating weeds prevent sunlight penetrating the water and this affects the entire food chain, causing the deterioration of aquatic biodiversity.
- When chemicals are used to control aquatic weeds, the mass-decay of organic matter causes anaerobic ("without oxygen") conditions to develop. Under such conditions, bacteria may release mineral elements from detritus into the water, and these give the water an unpleasant smell and taste.

CONTROL OF ALIEN INVASIVE PLANTS

There are four basic methods of controlling alien invasive plants:

- **Mechanical control:** This involves removing the invasive plants or damaging them severely by physical actions such as uprooting, clear-felling, slashing, mowing, ring-barking or bark-stripping or by hauling aquatic weeds out of the water. Felled trees often coppice, and the soil disturbance caused during the control action often stimulates the seeds of the invasive plant to germinate after clearing. Therefore, follow-up actions are very important.
- **Chemical control:** This involves the application of registered herbicides to the invasive plants or to the soil surrounding them, with the aim of killing or suppressing the plants. The choice of herbicides, the correct application method, dosage, time of application and follow-up actions are very important. Consult the latest version of the publication by Vermeulen *et al* (listed below) for guidelines in this respect.
- **Biological control:** This consists in the use of host-specific natural enemies to reduce the populations of the invasive plant to an acceptable level. Consult leaflet 1.3 in this series about biological control in general, and all subsequent leaflets for the biocontrol of specific plant species.
- **Indirect control:** This refers to methods that are not primarily aimed at killing invasive plants, but that can contribute towards their control, e.g. ploughing, the use of fire, the utilisation of parts of the plant, or the oversowing of an area with beneficial plant species.

The best results are often obtained if two or more of the above methods are combined. This strategy is called **integrated control**. Some of the combinations are mentioned below.

- Trees could be felled and the cut stumps treated with a chemical herbicide or a mycoherbicide (a formulation of fungal spores that can be sprayed onto a plant and will cause a fungal disease in the plant). Biocontrol agents could be released on the regrowth, or on an adjacent biocontrol refuge area, from where they can colonise the cleared area when the invaders regrow or when the seeds germinate.
- Trees could be felled and then burnt, and the resulting seedlings could then be sprayed with herbicide. Again, biocontrol agents could serve as a backup mechanism in the case of regrowth.
- Biocontrol agents could be released in a dense patch of cactus

while the isolated plants are treated with herbicides.

- Seed-feeding biocontrol agents could be released initially and, several years later, the trees could be cut down. If the soil seed-bank (consisting of the accumulated seeds in the soil) is persistent, the cleared area could then be burnt and the resulting seedlings treated with herbicides.
- Seed-feeding biocontrol agents could be released to limit further spread, while the trees are felled and used for timber or fuel. New plants could be grown from seeds that are obtained from a seed orchard, which will have to be protected chemically against the biocontrol agents.
- In combination with any of the above, suitable grass species should be established in the cleared area to rehabilitate the area, to prevent erosion and to reduce the risk of the cleared area being overrun with more invasive plants. Rehabilitation should be an integral part of any alien plant clearing operation.

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FURTHER READING

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