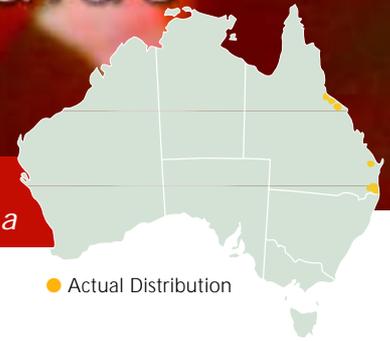


Weed Management Guide

Chinese rain tree –
Koelreuteria elegans ssp. formosana



● Actual Distribution

Chinese rain tree (*Koelreuteria elegans ssp. formosana*)

The problem

Koelreuteria elegans ssp. formosana is on the *Alert List for Environmental Weeds*, a list of 28 non-native plants that threaten biodiversity and cause other environmental damage. Although only in the early stages of establishment, these weeds have the potential to seriously degrade Australia's ecosystems.

K. elegans ssp. formosana is an ornamental landscape tree. It was first recognised as a naturalised environmental weed in the 1990s in the Brisbane City Council area where it has invaded urban parks, bushland, gullies and streets. It is naturalised in the USA and in Japan. *K. elegans ssp. formosana* is a fast-growing species that is tolerant of a wide range of environmental conditions.

The weed

Both *Koelreuteria paniculata* and *K. elegans ssp. formosana* have been widely planted in Australia. However, the species of particular concern in Australia has been identified by experts as *K. elegans ssp. formosana*. The two plants differ in a number of features. For example, the compound leaves of *K. paniculata* have coarse, rounded serrations on the edges and are divided by a common axis, whereas those of *K. elegans ssp. formosana* have pointed serrations and are divided twice. Also, the seed capsules of *K. paniculata* are

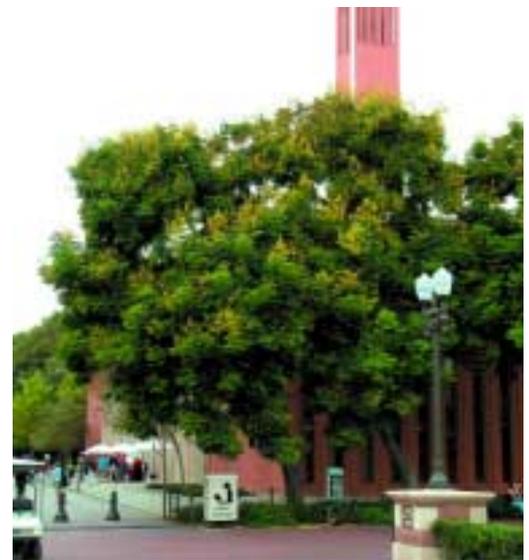
cone-shaped, in contrast to those of *K. elegans ssp. formosana* which are more egg-shaped.

A small, deciduous tree, *K. elegans ssp. formosana* has been recorded in Australia as growing to approximately 5 m tall, and up to 18 m under ideal conditions.

K. elegans ssp. formosana has compound leaves (ie made up of several distinct leaflets) that are dark green above and paler green below and of variable size and shape. The leaves are hairless, often appear feathery and measure up to 90 mm in length. The leaflets are narrow, ovate (pointed at one end and rounded at the other), and have irregularly toothed edges and a long, tapering point. Each leaflet is approximately 90 mm in length.

Flowers are small, to 20 mm in length, and occur in branched clusters at the stem tips. They are butter-yellow with five petals that vary in length until opening. Each flower contains seven to eight pale yellow stamens with hairy white filaments. The fruit is an inflated papery capsule that splits into three parts and is light pink to deep rose in colour. Fruits are up to 50 mm long and appear in large drooping clusters. The seeds are small, black and round and about 5 mm in diameter.

The trunk is light brown and smooth when young, but may develop ridges later. *K. elegans ssp. formosana* has a dense, rounded crown and may achieve a spread of 10–15 m when mature.



K. elegans ssp. formosana has been widely planted as an ornamental landscape or street tree.
Photo: B.R. Monroe, Cuyamaca College, California

Key points

- *K. elegans ssp. formosana* is a hardy, fast growing tree that is well adapted to Australian conditions.
- Prevention is the most cost-effective form of weed control. It is vital to keep uninfested areas free of *K. elegans ssp. formosana*.
- Preventing its spread will protect agricultural areas and natural environments of Queensland, Northern Territory, Western Australia and New South Wales (temperate and subtropical areas).
- If you see a tree that may be *K. elegans ssp. formosana* invading natural vegetation, contact your local council or state or territory weed management agency.

Growth calendar

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Flowering	■	■									■	■
Seed formation		■	■									
Seed drop	■	■	■	■	■	■	■	■	■	■	■	■
Germination							■	■	■			

■ General growth pattern

K. elegans ssp. *formosana* is a perennial tree that germinates in late winter and flowers from spring to summer. It is known to set seed in late summer / early autumn in Australia. Fruits are persistent, so seeds may drop year round. International experience suggests that *K. elegans* ssp. *formosana* is dormant in cold weather; however, this does not appear to occur in Australia in any season. This suggests that Australian conditions may promote more vigorous overall growth in the species as it is uninterrupted by seasonal cycles.



Each fruit of *K. elegans* ssp. *formosana* divides into three sections.
Photo: B.R. Monroe, Cuyamaca College, California

How it spreads

K. elegans ssp. *formosana* reproduces by seed, which can germinate within 6–8 days. Recorded infestations of the plant in Australia may be traced back to escapees from gardens, urban parks and street trees. It is not known exactly how the seeds are dispersed, but it is possible that water may contribute, as supported by evidence of infestation of gullies in Brisbane. Given the attractive,

plentiful fruits and seeds, birds may also be a factor in facilitating the spread of *K. elegans* ssp. *formosana*.

Although it is not known exactly how long *K. elegans* ssp. *formosana* seeds can survive in the soil (the soil 'seedbank'), experiments have shown that the seeds can achieve a 90–100% success rate of germination after 10 months of moist storage at 4 degrees C. This suggests that the seedbank may be viable for some time.

Anecdotal evidence suggests that *K. elegans* ssp. *formosana* seed may not be as viable in very cold climates, but in warmer climates seed viability is high and the plant is capable of becoming more invasive. Seedlings are often found beneath mature trees; however, successful germination of seed and subsequent growth of the seedling to maturity is dependent on the level of sunlight penetration.

Where it grows

K. elegans ssp. *formosana* is native to Taiwan and thrives in temperate climates. It tolerates full sun, partial shade, drought, frost, heat, well drained to wet soils, extended flooding and air pollution. It grows on a wide range of soil types and may be tolerant of light salt spray, but not of saline conditions.

To date, *K. elegans* ssp. *formosana* has only naturalised in Brisbane and near Noosa in Queensland and near Lismore in New South Wales. Naturalised specimens were first recorded from both states in 2001, growing amongst other weeds and native species in urban bushland, gullies, parks, undeveloped land and streets. The potential distribution of *K. elegans* ssp. *formosana* includes Western Australia and the Northern Territory.



The papery, inflated pink fruit of *K. elegans* ssp. *formosana* are prominent during summer.
Photo: B.R. Monroe, Cuyamaca College, California



The leaves are dark green on top and lighter green below.
Photo: USDA-NRCS Plants

Why we need to be 'alert' to *K. elegans ssp. formosana*

K. elegans ssp. formosana is a problem weed in Japan and the USA, where it has naturalised across five states. The decision to place *K. elegans ssp. formosana* on the Australian Alert List was based on this invasive behaviour.

Deliberately introduced to Australia as an ornamental landscape tree, *K. elegans ssp. formosana* has 'escaped' cultivation and naturalised. Brisbane City Council indicates that it is invading urban parks, bushland, gullies and streets around Brisbane.

In Lismore, New South Wales, there are several hundred *K. elegans ssp. formosana* saplings to 1 m or more in height that appear to have spread from adjacent cultivated specimens. Some of the naturalised plants in this area are even taller and are now reproducing. Due to its rapid growth habit and high seed viability in warmer climates, *K. elegans ssp. formosana* may crowd out native plant populations.

The Alert List for Environmental Weeds

The Federal Government's *Alert List for Environmental Weeds* was declared in 2001. It consists of 28 weed species that currently have limited distributions but potentially could cause significant damage. The following weed species are therefore targeted for eradication:

Scientific name	Common name	Scientific name	Common name
<i>Acacia catechu</i> var. <i>sundra</i>	cutch tree	<i>Koelreuteria elegans</i> ssp. <i>formosana</i>	Chinese rain tree
<i>Acacia karroo</i>	Karoo thorn	<i>Lachenalia reflexa</i>	yellow soldier
<i>Asystasia gangetica</i> ssp. <i>micrantha</i>	Chinese violet	<i>Lagarosiphon major</i>	lagarosiphon
<i>Barleria prionitis</i>	barleria	<i>Nassella charruana</i>	lobed needle grass
<i>Bassia scoparia</i>	kochia	<i>Nassella hyalina</i>	cane needle grass
<i>Calluna vulgaris</i>	heather	<i>Pelargonium alchemilloides</i>	garden geranium
<i>Chromolaena odorata</i>	Siam weed	<i>Pereskia aculeata</i>	leaf cactus
<i>Cynoglossum creticum</i>	blue hound's tongue	<i>Piptochaetium montevidense</i>	Uruguayan rice grass
<i>Cyperus teneristolon</i>	cyperus	<i>Praxelis clematidea</i>	praxelis
<i>Cytisus multiflorus</i>	white Spanish broom	<i>Retama raetam</i>	white weeping broom
<i>Dittrichia viscosa</i>	false yellowhead	<i>Senecio glastifolius</i>	holly leaved senecio
<i>Equisetum</i> spp.	horsetail species	<i>Thunbergia laurifolia</i>	laurel clock vine
<i>Gymnocoronis spilanthoides</i>	Senegal tea plant	<i>Tipuana tipu</i>	rosewood
<i>Hieracium aurantiacum</i>	orange hawkweed	<i>Trianoptiles solitaria</i>	subterranean Cape sedge

Weed control contacts

State / Territory	Department	Phone	Email	Website
ACT	Environment ACT	(02) 6207 9777	EnvironmentACT@act.gov.au	www.environment.act.gov.au
NSW	NSW Agriculture	1800 680 244	weeds@agric.nsw.gov.au	www.agric.nsw.gov.au
NT	Dept of Natural Resources, Environment and the Arts	(08) 8999 4567	weedinfo.nreta@nt.gov.au	www.nt.gov.au
Qld	Dept of Natural Resources and Mines	(07) 3896 3111	enquiries@nrm.qld.gov.au	www.nrm.qld.gov.au
SA	Dept of Water, Land and Biodiversity Conservation	(08) 8303 9500	apc@saugov.sa.gov.au	www.dwlbc.sa.gov.au
Tas	Dept of Primary Industries, Water and Environment	1300 368 550	Weeds.Enquiries@dpiwe.tas.gov.au	www.dpiwe.tas.gov.au
Vic	Dept of Primary Industries/Dept of Sustainability and Environment	136 186	customer.service@dpi.vic.gov.au	www.dpi.vic.gov.au www.dse.vic.gov.au
WA	Dept of Agriculture	(08) 9368 3333	enquiries@agric.wa.gov.au	www.agric.wa.gov.au

The above contacts can offer advice on weed control in your state or territory. If using herbicides always read the label and follow instructions carefully. Particular care should be taken when using herbicides near waterways because rainfall running off the land into waterways can carry herbicides with it. Permits from state or territory Environment Protection Authorities may be required if herbicides are to be sprayed on riverbanks.

What to do about it

Prevention is better than the cure

As with all weed management, prevention is better and more cost-effective than control. The annual cost of weeds to agriculture in Australia in terms of decreased productivity and management costs is estimated at \$4 billion. Environmental impacts are also significant and lead to a loss of biodiversity. To limit escalation of these impacts and costs, it is vital to prevent further introduction of new weed species, such as *K. elegans* ssp. *formosana*, into natural ecosystems.

Early detection and eradication are critical. Small infestations can be easily eradicated if they are detected early, but an ongoing commitment is needed to ensure new infestations do not establish.

Quarantine to prevent further introductions

Although on the Alert List, *K. elegans* ssp. *formosana* is currently a permitted import. However, importation of the plant to Australia is not encouraged due to its potential to be a serious environmental weed.

Mail order seeds are another potential source of infestation. Do not buy seeds via

the internet or from mail order catalogues unless you check with quarantine first and can be sure that they are free of weeds like *K. elegans* ssp. *formosana*. Call 1800 803 006 or see the Australian Quarantine and Inspection Service (AQIS) import conditions database <www.aqis.gov.au/icon>. Also, take care when travelling overseas that you do not choose souvenirs made from or containing seeds. Report any breaches of quarantine you see to AQIS.

Raising community awareness

Some 65% of weeds, including *K. elegans* ssp. *formosana*, which have recently established in Australia have escaped from plantings in gardens and parks. The detrimental impacts of these weeds far outweigh any potential horticultural benefits. The public should be made more aware of these impacts, and of other issues such as how to identify *K. elegans* ssp. *formosana* and what to do if they find it.



The trunk of *K. elegans* ssp. *formosana* is light brown and smooth when young, but may develop ridges with age.

Photo: USDA-NCRS Plants





Branched clusters of yellow, five-petalled flowers are prominent during spring.
Photo: USDA-NRCS Plants

Abundant, colourful yellow flowers and pink, inflated fruit can distinguish *K. elegans* ssp. *formosana*. Its leaflets are hairless, green and ovate – pointed at one end and rounded at the other – and are irregularly toothed along the edge. The tree has a light brown, smooth trunk when young that becomes more textured with age.

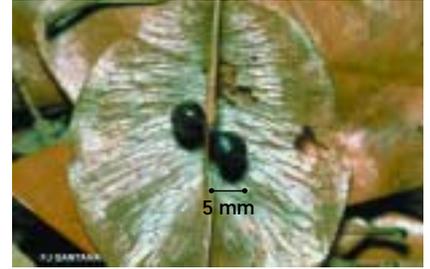
New infestations of *K. elegans* ssp. *formosana*

Because there are relatively few *K. elegans* ssp. *formosana* infestations, and it can potentially be eradicated before it becomes established, any new outbreaks

should be reported immediately to your state or territory weed management agency or local council. Do not try to control *K. elegans* ssp. *formosana* without their expert assistance. Control effort that is poorly performed or not followed up can actually help spread the weed and worsen the problem.

Legislation

There is currently no legislation to control *K. elegans* ssp. *formosana* but, as part of the *Alert List for Environmental Weeds*, it is marked for eradication and should not be imported into Australia or further spread.



The seeds of *K. elegans* ssp. *formosana* are small, black and round and are covered with a hard casing. They stay on the tree for a long time. They can germinate within 6–8 days.
Photo: F.J. Santana

Brisbane City Council has nominated *K. elegans* ssp. *formosana* as an environmental weed that can harm the environment and recommends it should not be grown.

In Ipswich, Queensland, both *K. elegans* ssp. *formosana* and *K. paniculata* have been named as environmental weeds, with rebates offered for the costs of control on private and public land.

Acknowledgments

Information and guide revision: Hillary Cherry (University of Florida, Center for Aquatic and Invasive Plants), Rod Wood (Brisbane City Council, Environment Department), John Hosking (NSW Agriculture/Weeds CRC).

Maps: Data used in the compilation of distribution map provided by Australian herbaria via Australia's Virtual Herbarium.

...case study

The invasion of *K. elegans* ssp. *formosana* into the urban parks and bushland of Brisbane

In Brisbane *K. elegans* ssp. *formosana* was commonly planted as an amenity/street tree until the early 1980s. However, about 10 years ago it was recognised as a naturalised environmental weed that was encroaching on Brisbane's natural bushland, urban parks and footpaths.

Since then, there has been an active campaign to remove *K. elegans* ssp. *formosana* from bushland areas, urban parks and streets. Initially, the incidence of the weed is mapped using GPS equipment, and area management plans are then devised. Control methods have

included the application of herbicide using the cut-stump, stem injection and basal bark methods. In street areas plants are hand pulled from the pavement. Control efforts are timed to occur prior to seed formation, in spring, to minimise seedbank replenishment.

If you find a plant that may be Chinese rain tree

Quick reference guide

Identification

You will first need to confirm its identity. Contact your state or territory weed management agency for help in identifying the plant. You will need to take note of the characteristics of the plant in order to accurately describe it. Some important features of *K. elegans* ssp. *formosana* are:

- Leaflets are dark green on top and paler beneath, have irregularly toothed edges, are pointed at one end and rounded at the other, and grow to approximately 90 mm long.
- Numerous yellow flowers to approximately 20 mm, with five petals, occur in branched clusters.

- Each flower has 7–8 pale yellow stamens with hairy white filaments.
- Fruit, to 50 mm long, is papery, inflated, divides into three parts and is light pink to rose pink in colour.
- Seeds are small, black and round.
- The trunk is smooth and light brown when young, and rougher when the tree matures.
- The tree has a dense rounded crown when mature.

Reporting occurrences

Once identified, new occurrences of *K. elegans* ssp. *formosana* should be reported to the relevant state or

territory weed management agency or local council, who will offer advice and assistance on its control. Because *K. elegans* ssp. *formosana* spreads so quickly and poses such a serious threat, its control should be undertaken with the appropriate expertise and adequate resources.

Follow-up work will be required

Once the initial infestation is controlled, follow-up monitoring and control will be required to ensure that reinfestation does not occur.

Collecting specimens

State or territory herbaria can also identify plants from good specimens. These organisations can provide advice on how to collect and preserve specimens.

State/Territory	Postal Address	Phone	Web
Australian National Herbarium	GPO Box 1600 Canberra, ACT, 2601	(02) 6246 5108	www.anbg.gov.au/cpbr/herbarium/index.html
National Herbarium of New South Wales	Mrs Macquaries Rd Sydney, NSW, 2000	(02) 9231 8111	www.rbg Syd.nsw.gov.au
National Herbarium of Victoria	Private Bag 2000 Birdwood Avenue South Yarra, Vic, 3141	(03) 9252 2300	www.rbg.vic.gov.au/biodiversity/herbarium.html
Northern Territory Herbarium	PO Box 496 Palmerston, NT, 0831	(08) 8999 4516	http://www.nt.gov.au/ipe/pwcnt/
Queensland Herbarium	c/- Brisbane Botanic Gardens Mt Coot-tha Rd Toowong, Qld, 4066	(07) 3896 9326	www.env.qld.gov.au/environment/science/herbarium
South Australian Plant Biodiversity Centre	PO Box 2732 Kent Town, SA, 5071	(08) 8222 9311	www.flora.sa.gov.au/index.html
Tasmanian Herbarium	Private Bag 4 Hobart, Tas, 7000	(03) 6226 2635	www.tmag.tas.gov.au/Herbarium/Herbarium2.htm
Western Australian Herbarium	Locked Bag 104 Bentley DC, WA, 6983	(08) 9334 0500	http://science.calm.wa.gov.au/herbarium/

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Printed on 100% recycled paper.

ISBN 1-920932-40-2

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