

Kudzu

Pueraria montana var. *lobata*



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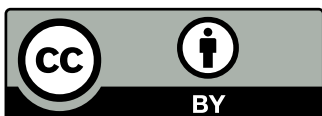
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Contents

Summary	4
Identity and taxonomy	4
Description	5
Longevity	5
Phenology	6
Reproduction, seed longevity and dispersal	6
History of introduction	6
Origin and worldwide distribution	6
Distribution in Australia	7
Preferred habitat and climate	9
Impact in other states	9
History as a weed overseas	10
Pest potential in Queensland	10
Control	12
References	13

Summary

Kudzu is a major pest in Japan and the United States. Loss of productivity caused by kudzu in the United States is estimated at US\$50 million per annum and some 2–3 million hectares of land are infested. Kudzu is also a weed in South Africa, Hawaii and New Zealand. The International Union for Conservation of Nature (IUCN) has included kudzu among the world's 100 most invasive species.

Kudzu has been present in Queensland since at least 1941 and its origin is unclear. Torres Strait Islanders consider it to be native and there is some evidence that it has a long history of use and transportation as a source of food, possibly originating in Asia but then taken south through Indonesia and across the Pacific.

Currently, kudzu exists as numerous small infestations scattered along the east coast of Queensland and north-east New South Wales. One of the largest infestations covers about 50–100 ha in the Gold Coast hinterland. It appears to have considerable potential for further spread, although it is difficult to explain why it has not already become abundant over a large area. The species' genetic variability, lack of viable seed production and susceptibility to rust fungus may offer explanations.

In general, kudzu spreads vegetatively and, as such, it does not appear capable of explosive or rapid spread. However, it can spread over large areas of suitable habitat wherever it has been planted. If it is ever sold as a garden plant or planted widely for erosion control it will probably become a serious pest in a short period of time.

Identity and taxonomy

Scientific name: *Pueraria montana* var. *lobata* (Willd.) Maesen & SM Almeida

Common names: Kudzu, kudzu vine, kudsu, kudzo, cudzu, wa yaka, aka, nepalem, Japanese arrowroot.

Synonyms: *Pueraria lobata* (Willd.) Ohwi, *Pueraria triloba* (Houtt.) Makino, *P. thunbergiana* (Sieb. & Zucc.) Benth, *P. hirsuta* (Thunb.) C. Schneider, *P. lobata* var. *thomsonii* (Benth.) Ohwi, *P. lobata* var. *chinensis* (Benth.) Ohwi, *Pueraria pseudohirsuta* (Tang & FT Wang), *Dolichos lobatus* Willd., *Dolichos hirsutus* Thunb., *Neustanthus chinensis* Benth., *Pachyrhizus thunbergianus* Siebold & Zucc.

Identity: *Pueraria montana* var. *lobata* is a member of the Fabaceae family. *Pueraria* is a variable genus of about 17 species, all confined to south-eastern Asia, Malesia and the western Pacific (Starr et al. 1999). The genus belongs to the tribe Phaseoleae, which is characterised by species with medium-sized to large leaves, unspecialised styles and long, multi-seeded pods. Two species, *P. phaseoloides* (Roxb.) Benth. and *P. lobata*, are widely cultivated in many tropical countries and often naturalise.

The taxonomy of kudzu is not clear, with multiple synonyms and multiple varieties within the species. For example, three varieties of *P. lobata* (a synonym of *P. montana* var. *lobata*) were distinguished by van der Maesen (1985), including var. *lobata* (which includes *P. thunbergiana*) and var. *thomsoni*, the latter weakly distinguished by its tendency to have larger flowers, stronger overlapping calyx lobes, the lower calyx lobes not much longer than the others, and sub-entire leaflets. Taxonomic uncertainty may be a consequence of the species' genetic variability (expressed as variable morphology).

Samples of kudzu recently collected in South East Queensland have been identified by the Queensland herbarium as *Pueraria montana* var. *lobata*. While kudzu collected from northern Queensland and the Torres Strait Islands is considered to be the same species by the Queensland Herbarium, this study questions whether this is the case—particularly since kudzu in the Torres Strait Islands does not appear to be invasive and appears far less aggressive than kudzu in South East Queensland.

Kudzu in the Torres Strait and North Queensland appears to have been introduced a long time ago, possibly as a traditional food source by islander people. In fact, Torres Strait locals consider kudzu to be a native plant and have long used its tubers as a food source (B Waterhouse, pers. comm.). Kudzu in South East Queensland might have originated from a different location within the species' overseas range, and may be genetically different to material in North Queensland. Of course, there are other explanations for apparent variation in vigour between specimens from South East Queensland and North Queensland, such as varying prevalence and impact of diseases such as rust fungi, different soil types and climate. Genetic analysis is required to clarify this matter.

Description

Kudzu is a deciduous, semi-woody, perennial vine capable of forming dense mats (Figure 1). It is difficult to detect when leafless in winter. Its stems can be up to 30 m long and can scramble over the ground or climb over other vegetation and structures. Flowers are produced in clusters of pseudoracemes, 10–40 cm in length. Individual flowers are 15–25 mm long and can be purple, blue or pink with a central patch of yellow (see cover photo). Leaves are arranged alternately along the stem with three leaflets per leaf. Leaflets are 8–18 cm long and 6–20 cm wide and are usually slightly lobed. Pods are brown with long spreading hairs. Each pod contains 3–10 seeds and is 4–13 cm long and 0.6–1.3 cm wide. The seeds are reddish brown with black mosaic, ovoid to ellipsoid, slightly flattened and 4–5 mm long (Wagner et al. 1990). Kudzu produces large (c. 60–90 cm) underground tubers and its roots can extend for 5 m into the ground. Kudzu is capable of very rapid growth and can grow up to 10–30 m per growing season and up to 30 cm in a day (Mitich 2000).

Longevity

Kudzu is a perennial plant. It is sensitive to frost and loses its leaves in response (Mitich 2000). However, it is quick to regrow from its tubers in spring.

Phenology

Flowering occurs in summer and usually commences on plants that are at least three years old (Southeast Exotic Pest Plant Council 2002).

Reproduction, seed longevity and dispersal

The primary mode of long-distance dispersal is movement of live plants by people. Kudzu has been transported and planted by people for use as a stock fodder, as a herb and as a garden ornamental. The seed-pods are quite sticky (hairy) and might adhere to clothing or the fur of animals (L Willsher, pers. comm.).

In the United States, kudzu's seed production varies from 0–1800 seeds per m² soil surface, with higher values occurring where vines are climbing over structures (Thornton 2001). Seed viability is extremely low and is assumed to be due to a lack of pollinators. However, Thornton (2001) demonstrated that there are a variety of both native and naturalised pollinators in the United States, the most important being native Hymenoptera. An exclusion cage study conducted in 1998 and 1999 revealed that low levels of kudzu seed viability were the result of arthropod damage. A concurrent inclusion cage study demonstrated that most of this damage was due to feeding by native Hemiptera (Thornton 2001). Feeding by a naturalised Asian bruchid (*Borowiecius ademptus* Sharp) resulted in a small amount of damage in both years (Thornton 2001). Seeds can remain viable for several years (Cacek 1998).

Kudzu can spread vegetatively. New roots are produced wherever the long, trailing stems touch the ground.

History of introduction

The history of kudzu in Queensland is unclear. The first official record of kudzu in Queensland is a specimen collected at the South Johnstone Experimental Station at Innisfail in 1941. As occurred in the United States and Hawaii, kudzu was probably introduced at some stage for use as either forage or for erosion control. Interestingly, some people in North Queensland and the Torres Strait Islands consider kudzu to be native and Torres Strait people have used the tubers as a 'traditional' source of food for many years. People in Atherton (North Queensland) have stated that the Chinese introduced kudzu during the early days of settlement. Coincidentally, the Chinese are believed to have introduced kudzu into Hawaii in the late 19th century (Degener 1934). It is difficult to say if this is fact or assumption.

Origin and worldwide distribution

The native range of kudzu is difficult to define. Most references state that kudzu is native to Asia (China, Japan, Korea, Thailand, Vietnam and Taiwan) and Indonesia (including Malaysia, Papua New Guinea and the Philippines) (Figure 1). While some references state that the native range of kudzu extends across the western Pacific region (Fiji, New Caledonia, Solomon Islands, Tonga, Micronesia and Vanuatu (e.g. GRIN 2005; Fosberg et al. 1979), this study questions whether this is a human-assisted extension to the plant's natural range. Some references state that kudzu is an aboriginal introduction to western Polynesia, where it is cultivated for its edible roots. Moreover, B Waterhouse (pers. comm.) reports that Torres Strait Islander people consider kudzu to be native. Hence, it appears that kudzu may have been used and perhaps traded across Indonesia, Papua New Guinea and the Pacific for use as a source of food for quite some time, possibly for hundreds of years.

The situation elsewhere is much clearer and there is little doubt that kudzu has naturalised in the United States, South America, South Africa and New Zealand within the last 100 years.



Figure 1. Possible native distribution of kudzu (*Pueraria montana* var. *lobata*).

Distribution in Australia

Kudzu has been recorded at numerous locations in coastal New South Wales and Queensland (Tables 1 and 2). It is common and considered native throughout the Torres Strait Islands. Small, scattered populations exist within the Wet Tropics, from Innisfail north to Cape Tribulation, and further north at Iron Range National Park in Cape York. In southern Queensland, it appears restricted to small populations in high rainfall coastal areas, such as Springbrook and Tallegbudgera Valley in the Gold Coast hinterland and Russell Island.

Table 1. Herbarium records of kudzu in Queensland (data courtesy of Queensland Herbarium, EPA, 2004; records arranged in chronological order).

Location	Year	Label notes
South Johnstone Experimental Station, Innisfail	1941	South Johnstone Experimental Station. Cultivated.
Atherton	1953	Atherton. Flowers had dropped off without the formation of fruit. Local residents consider this plant to be a yam introduced by the Chinese in the early days of settlement.
Kerry (ex Conondale)	1969	Cultivated. Climbing over willow tree on creek bank. Seed planted came from Conondale in 1960.
Albert River, near Beaudesert	1971	Kerry, south of Beaudesert on Albert River.
Murray Island, Torres Strait	1971	Murray Island, east Torres Strait. Native name <i>weskepu</i> . Edible root.
Dauan Island, Murray Group	1974	Dauan Island, Murray Group.
Cape Tribulation	1983	
Armit Island, Whitsundays	1985	
Widgee Shire	1985	Tagigan Road, Widgee Shire. Roadside. Rampant creeper, growing some 5 m into trees.
Near Gympie	1986	Near Gympie, site of old DPI nursery.
Russell River	1988	
Moa Island, Torres Strait	1989	Moa Island c. 1.5 km WNW of St Pauls. Small pocket of closed forest on low rocky hills. A vigorous twining legume. Flowers mauve, keel darker than other petals, standard with a yellow blotch near the base. Material in spirit collection.
Lockhart River	1990	
Mount Whitfield National Park, Cairns	1992	Southern boundary of Mount Whitfield Environmental Park. Along drainage line. Robust vine. Leaves discolourous. Petals purple with yellow centre.
Gabba Island, Torres Strait.	1994	Gabba Island.
Iron Range National Park (Cape York)	1999	
Mossman Gorge National Park	2001	Near entrance of Mossman Gorge National Park. Rampant vine, smothering small trees.
Darnley Island, Torres Strait	2002	Darnley Island, Torres Strait (road to school). Widespread and locally common native plant. Red soil on basalt. Robust, twining climber. Leaves discolourous, often glabrescent (remain pubescent on some parts of the plant). Pods flat.
Springbrook	2002	Springbrook Conservation Area (on cleared electricity easement east of Springbrook Road).
Springbrook	2003	c. 3 km south (on left near abandoned house & concrete tank) of Springbrook Rd junction & Numinbah Rd.
Springbrook	2003	Gold Coast to Springbrook Road—eastern side of road 0.5 km past Appletree Park. Escarpment of Springbrook National Park. Cultivation/forest verge.
Skeleton Creek	2003	Centenary Park.
Stephen Island, Torres Strait	2004	
Kin Kin	no date	Cultivated.

Table 2. Herbarium records of kudzu in New South Wales (data courtesy of New South Wales Herbarium 2003).

Location	Year	Label notes
Terranora	1926	Naturalised
Mullumbimby	1945	Cooper Track, Mullumbimby. Along gullies. Takes over lantana. Stock eat parts of plant. No flowers present.
Murwillumbah	1964	Cultivated.
Lismore	1965	Naturalised. Palatable to stock. 9–12 m vine.
Nabiac	1968	Naturalised.
Bellingen Shire	1985	Recorded by Bellingen Shire Council (no other information).
Pickton	1991	10 km south of Pickton, along roadside. About 1 ha.
Tyalgum	1999	5 km north of Tyalgum. Vigorous vine reaching 3m into canopy.
Lord Howe Island	n/a	Lord Howe Island, Signal Point, roadside, grassland. Naturalised vine. Vigorous. Rare.

Preferred habitat and climate

Kudzu prefers open, disturbed habitats with fertile, well-drained soils. It is an opportunistic plant that is quick to colonise and dominate forest edges, abandoned fields and roadsides (USGS 1999). While kudzu grows best under full sun it is one of the more shade-tolerant legumes (Fujita et al. 1991). Growth is most prolific where annual rainfall exceeds 1000 mm. Kudzu stores moisture within its roots and tubers and, as a result, can survive in seasonally dry areas (Mitich 2000). Kudzu prefers mild winters of 5–15 °C and summers with temperatures above 25 °C. However, it can grow in Korea where the temperature drops to –30 °C. In Japan, kudzu grows from lowland areas up to elevations of 1000 m within the latitudinal range of 44°N to 30°N (Mitich 2000). Similarly, kudzu grows prolifically in low elevation areas in Hawaii, but can grow in areas up to 700 m above sea level.

Kudzu grows in a wide variety of soil types, including soils that are nutrient-deficient. Survival and growth on poor soils is enhanced by its ability to fix atmospheric nitrogen within specialised nodules on its roots (Miller & Edwards 1983). It does not grow well in soils that are either very wet or have a high pH (Mitich 2000).

Impact in other states

Kudzu is a locally significant weed in coastal areas of northern New South Wales. However, this study was unable to find any data on its impact.

History as a weed overseas

The IUCN has listed kudzu among the world's 100 worst invasive species (IUCN Global Invasive Species Database 2002).

Kudzu was first introduced into the United States in 1876 and was promoted for erosion control, as a forage crop and as an ornamental plant. Its promotion to control soil erosion was particularly enthusiastic with the United States Soil Conservation Service distributing approximately 85 million kudzu seedlings between 1933 and 1953. Farmers were paid up to \$8 per acre to plant kudzu to prevent soil erosion.

The United States Department of Agriculture listed kudzu as a common weed in 1970. In 1997, Florida listed kudzu as one of the state's most invasive weed species (USGS 1999). It is now abundant in the south-eastern states of the United States, including Alabama, Florida, Georgia, Illinois, Iowa, Kentucky, Maryland, Mississippi, Nebraska, New York, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia and Washington.

It is estimated that loss of productivity in the United States attributed to kudzu is US\$50 million per annum. In the United States, 2–3 million hectares of land are infested (IUCN 2002). Kudzu is a noxious weed in five United States states: Florida, Kansas, Oregon, Pennsylvania and West Virginia. In the south-eastern United States, kudzu smothers fences, forests, pastures and farmland on a dramatic scale and has been described as 'the vine that ate the south'.

Kudzu is capable of rapid growth and is notorious in the south-eastern United States for forming a dense, blanket-like growth over houses, cars, trailers, signs and any other structures in its path. Kudzu is one of the weeds of greatest concern in Great Smoky Mountain National Park and can replace native vegetation through rapid vegetative expansion (Loope 1992).

Kudzu was probably introduced into Hawaii by the Chinese during the latter part of the 19th century (Degener 1934). Today, kudzu occurs on several islands of Hawaii (Wagner et al. 1990). In Hawaii, it threatens to smother native vegetation, known locally as *taro loi*, as well as agricultural land. Kudzu is also a weed in South Africa (Wells et al. 1986) and New Zealand. Infestations in New Zealand occur in one area of 3000 m² spreading from a roadside to a neighbouring pasture, 1000 m² along a highway and another has been subject to successful control in a garden (IUCN 2002).

Kudzu is a major weed in Japan, where it is native (Holm et al. 1979).

Pest potential in Queensland

While kudzu may be native to the Torres Strait Islands, and has been cultivated there for some time, there seems little doubt that it has the potential to increase its spread in Queensland.

Kudzu has the potential to become a major pest in coastal areas of Queensland where annual rainfall exceeds 1000 mm. This includes the Wet Tropics region and coastal South East Queensland. It is predicted to grow most prolifically in disturbed habitats (under full sun), such as forest edges, roadsides and abandoned farmland. Existing infestations in South East Queensland provide a valuable insight into the species' long-term pest potential (Figure 2).

Within suitable habitats, kudzu could form extensive, dense infestations, as it has already done in the United States and Japan. Potential losses associated with lost agricultural production and control costs are difficult to estimate. However, considering the species' impacts in the United States (US\$50 million per annum), its impact in Queensland could be substantial.

Kudzu is not expected to spread rapidly in Queensland unless it is planted on a large scale. This study suggests that the planting of some 85 million kudzu plants for erosion control in the United States was the key factor in the plant's spectacular success and status as one of the country's worst weeds. Without deliberate cultivation and dispersal by humans, kudzu is slow to spread. The literature suggests that kudzu produces seeds sporadically, depending on the availability of insect pollinators perhaps, and the seed that is produced seems to have very low viability. The primary mode of spread is vegetative, which kudzu achieves very effectively. Once planted, it spreads radially, wherever suitable habitat exists.



Figure 2. One of the largest infestations of kudzu in Queensland (Tallebudgera Valley, Gold Coast).

Control

Kudzu has been controlled in the United States using the following techniques:

- Cut-stump application with Tordon DS (1:4 in water), with BS1000 surfactant at one millilitre per litre.
- Foliar spray with Grazon at five millilitres per litre.

Experiments in New South Wales suggest that glyphosate has limited efficacy (Big Scrub Rainforest Landcare Group & Richmond Catchment Management Committee 2000). For successful control of kudzu, the extensive root system must be destroyed.

Large infestations in the United States have taken up to 10 years to bring under control (Virginia Native Plant Society 2002). Livestock, including cattle and goats, will consume kudzu and can contribute to effective control, provided the roots and tubers are eventually destroyed. Fire does not appear to be effective at killing the crown of the plant or its tubers.

The United States Forestry Service is researching a biological control agent for kudzu. A root knot nematode (*Meloidogyne* sp.), a 'blackleg' fungus disease, a viral mosaic disease and a rust fungus all cause mild injury to kudzu in the United States (USGS 1999).

A rust fungus (*Phakopsora pachrhizi*) was collected from kudzu at the Tallebudgera Valley, Queensland by Department of Natural Resources and Mines staff in 2004. Kudzu at this site was observed to grow vigorously at the start of summer but appeared to become unhealthy and partially defoliated by the rust at the end of summer. However, it is difficult to say whether the damage was in fact caused by the rust or simply the normal loss of leaves associated with cool weather.

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