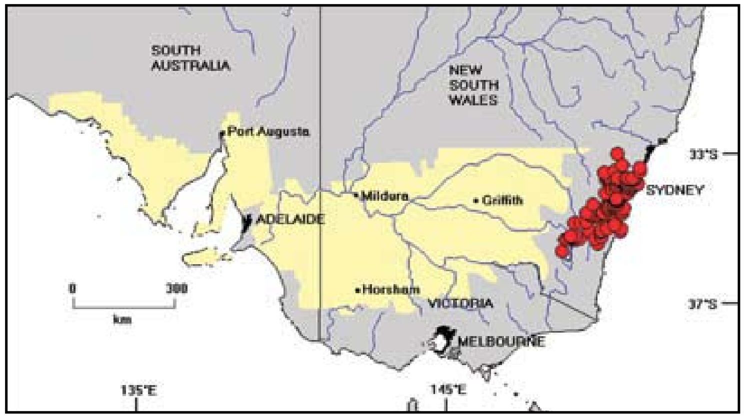
Acacia decurrens Willd.

Common Names

Green Wattle (Standard Trade Name), Early Black Wattle, Wattah (aboriginal name, *fide* Maiden 1889).



Map 17. Distribution of *A. decurrens.*

Habit

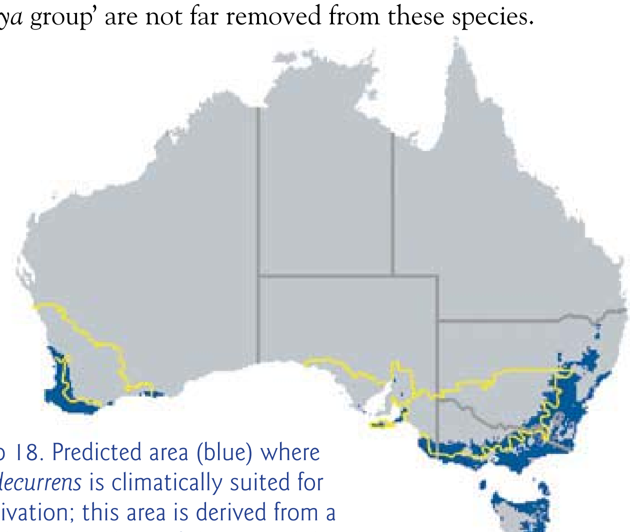
Shapely erect trees 5–10 (–15) m tall but sometimes attaining 20–22 m tall under favourable conditions (Boland 1987, Pryor & Banks 1991), commonly with single, straight to almost straight main stems, strong, shallow lateral roots are developed. Bark smooth but may become fissured on main trunks of mature plants, dark grey to almost black.

Botanical descriptions and illustrations/photographs are provided by Maiden (1907), Costermans (1981), Simmons (1987), Fairley & Moore (1989), Tame (1992), Whibley & Symon (1992), Tindale & Kodela (2001 and 2001a) and Kodela (2002)

Taxonomy

This species belongs to *Acacia* section *Botrycephalae*, a group of 44 mostly arborescent species characterized by having bipinnate adult foliage and flower heads normally arranged in elongated racemes (Orchard & Wilson 2001). These species predominate in temperate areas of eastern and southeastern Australia (Hnatiuk & Maslin 1988, Maslin & Pedley 1988). There are seven species of *Botrycephalae* detailed in this report, namely, *A. baileyana, A. dealbata* subsp. *dealbata, A. decurrens, A. filicifolia, A. leucoclada* subsp. *leucoclada, A. mearnsii* and *A. parramattensis*. A number of recent studies have suggested that species of section *Botrycephalae* are most closely related to certain racemose species of section *Phyllodineae* (foliage phyllodinous) from eastern Australia, see Maslin & Stirton (1998) and Maslin *et al*. (2003) for reviews. Of the phyllodinous species included in this report those having presumed closest affinities to species of *Botrycephalae* include *A. linearifolia, A. neriifolia* and *A. pycnantha*; members of the '*Acacia microbotrya* group' are not far removed from these species.

Acacia decurrens is related to *A. dangarensis* and is similar to *A. parramattensis* and *A. filicifolia* but is readily distinguished from all these taxa by its branchlets which are prominently angled by conspicuous winged ridges. The species commonly hybridizes with *A. baileyana* (see under **Genetics** below). A study by Tindale and Roux (1969) of flavonoid and condensed-tannin contents of the heartwood and bark of *Acacia* recognized four groups within section *Botrycephalae*; this study placed *A. decurrens* in a group containing *A. constablei, A. irrorata subsp. velutinella, A. mearnsii, A. parramattensis* and



Map 18. Predicted area (blue) where *A. decurrens* is climatically suited for cultivation; this area is derived from a bioclimatic analysis of the natural distribution (red circles, Map 17), see also Table 5. Target area shown in yellow.

Figure 8. *Acacia decurrens*

A – Adult trees with insert of stem base. (Photo: B.R. Maslin)

B – Juvenile stand (regrowth from seed). (Photo: B.R. Maslin)

C – Upturned mature plant showing roots. (Photo: B.R. Maslin)

D – Wood core from 10 year old plant. (Photo: P. Macdonnell)

E – Mature stand. (Photo: B.R. Maslin)

F – Branch showing racemose inflorescences & dark green bipinnate leaves. (Photo: B.R. Maslin)

A. trachyphloia. *Acacia parramattensis* is probably often mistakenly grown as *A. decurrens* according to Tame (1992).

Distribution and habitat

Endemic in New South Wales where it occurs chiefly on the coast and tablelands from the Hunter Valley south to the Australian Capital Territory. This distribution is outside the target area but not far from its eastern border. *Acacia decurrens* has been widely cultivated as an ornamental and has become naturalized in many areas, both within Australia and abroad (see below under **Cultivation** and **Weed potential)**. In Australia naturalized populations occur in southwest Western Australia, southeast South Australia (see Whibley & Symon 1992), southeast Queensland (see Pedley 1980), parts of New South Wales, the Australian Capital Territory, Victoria (see Entwistle 1996) and Tasmania. Tindale & Kodela (2001) provide maps of both the 'natural' and naturalized distributions. As noted by Burbidge & Gray (1970) in parts of New South Wales distinguishing between 'natural' and naturalized occurrences is difficult. *Acacia decurrens* grows in open forest or woodland, on hillsides or gullies, on clays and clay loams usually derived from shale. Comprehensive summaries of habitat characteristics are given in CAB International (2000).

Flowering and fruiting

Flowers mostly between July and early September, but this may vary with seasonal conditions, locality and particularly altitude (Clemson 1985). Kodela (2002) indicates that flowering can extend to November. The time between flowering and pod maturation is 5–6 months (Boland 1987) with seeds being present from November to January, but pods are not produced every year (Pryor & Banks 1991).

Biological features

A relatively short-lived species which declines in vigour after 10–15 years (Pryor & Banks 1991). Boland (1987) considered it to have moderate frost tolerance. The species is reported as having the ability to coppice and root sucker (Ruskin 1983), however, the accuracy of this report requires further investigation (see also under **Yield** below). In our experience this species has at best only weak root suckering and coppicing ability. For example, 32 month old plants under trial near Canberra did not display any suckering (Searle *et al*. 1998). Similarly, 62 month old plants under trial in Western Australia showed no evidence of root suckers or coppicing 12 months after harvest (Barbour 2000).

Genetics

As noted by Tindale & Kodela (2001) *A. decurrens* commonly hybridises with *A. baileyana*; these hybrids are referred to as *A.* x *nabonnandii* Nash in Jacobs & Pickard (1981) and are discussed by Cheel (1935). The hybrids appear to be more susceptible to insect galls than either parent species (Burbidge & Gray 1970).

Philp & Sherry (1946 & 1949) reviewed the hybridity between *A. decurrens* and *A. mearnsii* in cultivation in South Africa with a view to improving forestry stock. Features of the hybrids are discussed by Moffett (1965a & b) and Moffett & Nixon (1958). Moran *et al*. (1989) included *A. decurrens* in an allozyme study to estimate overall genetic diversity in a range of *Acacia* species. Based on plants from the Goulburn population, *A. decurrens* had similar levels of expected heterozygosity ($H_E = 0.156$) relative to the other *Acacia* species assayed (H_E mean of eight species = 0.147). The above summary is taken from CAB International (2000).

A study of the breeding behaviour of *A. decurrens* and *A. mearnsii* by Moffett & Nixon (1974) showed that self-fertilization in both these species leads to a decrease in fertility and general vigour.

Chromosome number: $2n = 26$ (Ghimpu 1929).

Cultivation

Acacia decurrens has been grown in the following countries abroad: Argentina, Bolivia, Brazil, Chile, China, Colombia, Congo, Ecuador, Ethiopia, Haiti, Honduras, India, Indonesia, Japan, Kenya, Mexico, Morocco, Myanmar, Nepal, New Zealand, Papua New Guinea, Philippines, Russia, Rwanda, South Africa, Sri Lanka, Swaziland, Taiwan, Tanzania, Turkey, United States of America, Uruguay, Vietnam, Zaire, Zimbabwe (CAB International 2000 based on records of the Australian Tree Seed Centre, CSIRO, Forestry and Forestry Products). The species has also been trialled in Australia, e.g. near Canberra (Searle *et al.* 1998) and southwest Western Australia (Barbour 1995).

CAB International (2000) provides a comprehensive summary of the silvicultural characteristics, practice and management of *A. decurrens*, and the following information is taken directly from this source.

Establishment

Acacia decurrens can be easily propagated from seed but, as with most acacias, the seed must be pre-treated to induce germination. The best method is to boil the seeds at 100°C for 1 minute in a relatively large volume of water (ATSC 1998). The seeds should then be allowed to cool and imbibe water for 24 hours; seeds that float to the surface are normally not viable and should be discarded; viable seeds should become swollen and sink. The seeds can also be scarified (Wrigley & Fagg 1996); mechanical nicking of the seed coat is also an option. The average viability of *A. decurrens* seeds, based on laboratory tests of 12 provenances, is 57, 000 seeds per kilogram and the recommended temperature for optimum germination is 25°C; germination commences after five days and all viable seeds normally germinate within 25 days (ATSC 1998). More than 60% of seed stored for 17 years has been shown to germinate (Smith 1930).

Acacia decurrens can also be propagated by vegetative means. Darus (1992) provides a summary of important factors to consider for successful vegetative propagation of acacias using cuttings and tissue culture techniques. These include: age of stock plants; rooting medium, basal medium and type and concentration levels of rooting hormones and growth hormones used.

In the nursery, direct sowing of pre-treated seed into germination trays and subsequent transplanting of vigourous germinants into tubes at the two-phyllode stage is an effective method for raising seedlings (Ryan *et al.* 1987). Alternatively, pre-treated seeds can be sown directly into pots. A mix of 1 part peat moss and 2 parts vermiculite is an appropriate potting medium. A slow-release fertiliser should be added to the sowing mix at the nursery phase. Foliar applications of fertiliser are not advisable due to the difficulty of adding sufficient nutrients at low concentrations to avoid foliage burn and to an increased susceptibility of plants to pathogens (Ryan *et al.* 1987). At the 4–6 phyllode stage, seedlings can be removed from the greenhouse and kept under 50% shade for 3–4 days before exposure to full sun.

Seedlings from nursery-grown stock are normally used to establish industrial plantations, however, in Swaziland woodlots of *A. decurrens* were established by direct sowing (Allen *et al.* 1988). Plantations for chipwood, pulpwood or firewood are not usually thinned or pruned but clear-felled at age 6–15 years.

Midgley and Vivekanandan (1987) provide silvicultural methods for establishing acacias in Sri Lanka which included *A. decurrens*. These authors emphasise that appropriate levels of weed control and fertiliser application are essential components in the silviculture of *A. decurrens* if optimum yields are to be obtained.

Ectomychorrhizal associations improve growth by enhancing absorption of nutrients from the soil (Reddell & Warren 1987). *Acacia decurrens* is a relatively promiscuous host for Rhizobia as 75–100% of Rhizobium strains tested successfully nodulated (Roughley 1987). Growth is improved by the application of NPK fertiliser and frequent weeding ensures optimal growing conditions (Midgley & Vivekanandan 1987, Searle *et al.* 1998).

Acacia decurrens has the potential to produce clear, straight stems when close-grown and it regenerates via seedling recruitment (Ruskin 1983). Light fire will promote profuse seedling regeneration (Midgley & Vivekanandan 1987) with 32 000 seedlings/ha, up to 3–4 m in height, having been recorded after two years (Weeraratne 1964). Protection from livestock and other browsing animals is important during the establishment phase.

Yield

Acacia decurrens was represented at two sites in fuelwood trials near Canberra, A.C.T. (CSIRO 2001). The sites at Kowen and Uriarra had a mean annual rainfall of 630 mm and 824 mm respectively. In the two best performing provenances (Goulburn and Mittagong), variation was evident for biomass production based on assessments made at 2.6 years. However, there were negligible differences between provenances for biomass at 5.2 years of age. Interestingly, there were also only marginal differences for growth between these two provenances at either site despite the higher rainfall at Uriarra. At age 5.2 years mean heights ranged from 6.1–6.4 m and dbh ranged from 9.2–9.6 cm at both sites. These data suggest this species has excellent potential to be cultivated in short phase cropping rotations at suitable sites.

In trials involving 12 bipinnate acacias at three sites in Western Australia, Barbour (2000) ranked *A. decurrens* second to *A. mearnsii* for wood production across all three sites when assessed at 5.5 years of age. In these trials, *A. decurrens* was one of only three species identified as having potential to be developed commercially for its bark tannin (for wood adhesives) and for fuelwood, in Western Australia. Some marked differences in performance between provenances, however, were evident in these trials. For example, of the two provenances tested the Picton-Mittagong provenance out-ranked the Goulburn provenance at all three sites, based on assessments at two years of age. There were negligible differences in biomass production for *A. decurrens* at two sites (Busselton and Mt Barker). In these trials, the performance of plants at the Mt Barker and Darkan sites are of most interest to the present study as these sites both receive 650 mm mean annual rainfall. The report highlighted the fact that high evaporation and high summer temperatures at the Darkan site were too severe for the successful establishment of bipinnate acacias.

Ryan & Bell (1989) tested one seedlot of *A. decurrens* in two trials near Gympie, Queensland. At 18 months the plants in one trial were 3.2 m tall with stem diameter at ground level measuring 6.2 cm while at the other they were 4.3 m tall with a 7.5 cm ground level diameter. In these trials, coppicing in *A. decurrens* was poor for all three treatments when cut at 0.1, 0.5 and 1.0 m above ground level. Interestingly, root suckering was a focus of these trials and none was noted for this species.

In Sri Lanka, the Goulburn provenance of *A. decurrens* that had been used by Searle *et al.* (1998) in the Canberra trials recorded moderate growth of 3.1 m in height and 2.6 cm dbh at age 2.5 years; the trial site was 1160 m in altitude and had 1580 mm mean annual rainfall (Weerawardane & Vivekanandan 1991). Elsewhere in Sri Lanka, *A. decurrens* was one of the best species for diameter growth of all fuelwood and timber species tested (Weerawardane & Phillips 1991), averaging 25m^3 per ha per year according to Ruskin (1983).

In the Natal Midlands, South Africa, 14-year-old commercial stands of *A. decurrens* and *A. mearnsii* were assessed for bark yield and pole yield by Coetzee (1986). *Acacia decurrens* yielded 30% more bark than *A. mearnsii*, but as its bark is of inferior quality for tanning, this result was not considered to have commercial significance.

In trials involving 15 acacias at two sites in Victoria, *A. decurrens* was amongst the best performing species (Bird *et al.* 1998). At age 34 months, the mean height of *A. decurrens* was 2.5 - 4.8 m, while mean diamaters ranged from 64-78 cm. The mean annual rainfall at the trial sites was 700 mm.

Pests and diseases

The following information is taken largely from CAB International (2000).

Diseases known to attack *A. decurrens* are a canker, *Corticum salmonicolor*, in Malaysia (Singh 1973); gummosis (*Ceratocystis fimbriata*) in Brasil (Ribeiro *et al*. 1988); and root rot caused by *Ganoderma lucidum* in Madhya Pradesh, India (Harsh *et al*. 1993).

A minor pest is *Trichilogaster trilineata* which lays eggs in flower buds of *A. decurrens* and other bipinnate acacias. The plant then produces spherical galls around each egg and these may replace most of the flowers on a tree (New 1984). In New Zealand seeds of *A. decurrens* were heavily infested with the phytophagous chalcid, *Eurytoma acaciae* (Cameron 1910) and in Hawaii the species is attacked by four species of native Cerambycidae (Davis 1953). 127 beetle `morphospecies' belonging to the Coleoptera were recorded on *A. decurrens* by New (1979). Ruskin (1983) notes that *A. decurrens* is susceptible to the defoliator *Acanthopsyche junode* and the rust fungus *Uromycladium*. In Australia, the wood of *A. decurrens* is susceptible to Lyctid borer attack which reduces its longevity (Wrigley & Fagg 1996, Pryor & Banks 1991).

Weed potential

Due primarily to its prolific seeding *A. decurrens* can become an environmental weed under certain favourable conditions. It has been widely cultivated as an ornamental and has become naturalized in many areas, including Hawaii, New Zealand, South Africa, Mediterranean Europe and elsewhere. In South Africa it is a Declared Invader (category 2) species (Henderson 2001). Attempts at control of *A. decurrens* in South Africa include the use of herbicides; also, seed-feeding weevils are currently under investigation as a biocontrol agent of this species.

Wood

The wood of *A. decurrens* is light, tough and strong, the sapwood is white and the heartwood pinkish; it has an air-dry density of about 720 kg/m^3 (Bootle 1983) and a basic density of 457 kg/m^3 (Hannah *et al*. 1977). Ilic *et al*. (2000) provides an estimated basic density from air-dry (12%) MC as 520 kg/m^3.

Utilisation

The following information is taken largely from the comprehensive summary of utilisation provided by CAB International (2000).

Wood

Acacia decurrens has the potential to provide an excellent source of fuelwood. Maiden (1889) noted that the wood provides an excellent fuel even in its green state. Ruskin (1983) reports that the wood has a calorific potential of 3 530–3 949 kcal per kg. Individual farm woodlots of both *A. decurrens* and *A. mearnsii* are an important source of woody biomass production in Swaziland (Allen *et al*. 1988, Allen 1990).

The wood of *A. decurrens* has been used for building poles, mine props, fence posts and hardboard production (Ruskin 1983) but according to this author it is not suitable for sawn timber production due to its small dimension. In India it has been considered a valuable timber species (Gamble 1972) and, according to Maiden (1889), it was grown at Coonoor (New South Wales) on a somewhat extensive scale. *Acacia decurrens* was noted a good pole producer in South Africa as it developed only fine lateral branches (Boland 1987).

This species is one of several temperate species reported by Clark *et al*. (1994) as having kraft pulp yields within the range of commercial pulpwoods. Kraft pulping and bleaching studies of plantation-grown eucalypts and acacias, which included *A. decurrens*, pulped to relatively high yields (50–56%) and their pulps bleached readily to high brightness (Hannah *et al*. 1977). *Acacia decurrens* was amongst the species that showed low bulk, high bursting strength and high breaking length and was considered suitable for fine paper furnishes. Pulp from *A. decurrens* was readily bleached to high brightness levels and the bleached pulp properties would be suitable for end products such as writing and printing papers (Logan & Balodis 1982).

Tannin

In the past, *A. decurrens* was used in Australia for the tanning of hides when the industry was locally viable (Clemson 1985), however, its bark is much thinner and inferior in quality to *A. mearnsii* (Maiden 1889). The bark of *A. decurrens* yields 35–40% of good quality tannin but contains an excessively red-coloured tannin extract (Ruskin 1983, Luyt *et al*. 1987). Thus, its tannin is considered to reduce the value of leather and tannin from species such as *A. mearnsii* is preferred. Ruskin (1983), however, notes that this problem with tannin from *A. decurrens* could be overcome by changing the tanning process or by the addition of additives. *Acacia decurrens* is still the main tannin producing species exploited in Indonesia (Prayitno 1982), where the addition of 5–10% of tannin-formaldehyde, made from the tannin from *A. decurrens* bark, is used to manufacture fibreboard from mixed wood species (Silitonga *et al*. 1974). Tannin-formaldehyde from *A. decurrens* significantly improves the strength, water-absorption and thickness-swelling properties of the boards and the cost of its production is reduced by the addition of urea to the tannin (Santoso & Sutigno 1995).

Gum

Acacia decurrens is also known for the production of wattle gum. According to Maiden (1889), the tree yields copious gum during the summer months and was used to make jelly-like confection; its gum has also been used as a substitute for gum arabic (Macmillan *et al*. 1991).

Land use and environmental

Acacia decurrens is a moderately deep rooted, drought-tolerant, nitrogen-fixing tree, widely planted to shade crops (Macmillan *et al*. 1991). It has been used for windbreaks, shelterbelts, as a shade crop and for stabilisation of ash spoil. In Sri Lanka, it was introduced by tea planters around the 1870s and widely-used above an altitude of 1000 m for hedges, shelterbelts and windbreaks, shade trees, green manure and fuelwood production (Midgley & Vivekanandan 1987). It was a major component in the Sri Lankan government fuelwood plantations until 1936 (Streets 1962, Champion 1935) and is used in ornamental plantings (Midgley & Vivekanandan 1987, Clemson 1985).

Acacia decurrens was included in an investigation of stabilisation techniques to control wind erosion of an ash disposal site at Port Kembla, Australia where salinity of the ash, exposure to winds, and high erodibility were particular problems (Junor 1978). It established and grew well and along with various methods of a bituminous emulsion seal, grass sowing, strip sodding and addition of an earth layer, enabled the site to be developed as a recreational area.

Acacia decurrens also competes well with weeds (Ruskin 1983). If established in dense stands, the accumulation of shed foliage from *A. decurrens* forms a thick ground cover which, over time, eliminates the growth or establishment of other vegetation at the site.

Fodder

Acacia decurrens is not known for its fodder value in Australia.

Other uses

Other known uses of *A. decurrens* include the following: medium to abundant quantities of pollen are produced during good flowering seasons and which is a potential source of forage to sustain bee hives (Clemson 1985); according to Subba Rao (1959) the seeds have a high oil content with potential for use as a `drying oil'; it has been used for green manure production (Webb *et al*. 1984); and dyes extracted from the leaves of *A. decurrens* have been used to colour wool yellow or green depending on the mordant used (Martin 1974).

This species is well known as an ornamental.

Potential for crop development

Acacia decurrens is regarded as having reasonably good prospects as a crop plant for high volume wood production. *Acacia decurrens* is ranked a category 2 species and would be best suited to development as a phase crop (see Table 6). Available evidence suggests that this species would not be suited as a coppice crop. Vegetative regrowth is seemingly poor, however, coppicing trials could be undertaken to ascertain if two or more rotations can be produced from the original planting stock. Provenance variation for coppicing ability and seasonal timing of pollarding may be factor in this species.

Acacia decurrens develops an excellent growth with the potential to produce clear, straight stems and produces good quantities of woody biomass. The wood is pale coloured of low density (457–520 kg/m^3) and is within the range needed for reconstituted wood products, commercial pulpwoods and other wood products (see under **Utilisation** above). Additional important end-product possibilities for this species could include gum and tannin. *Acacia decurrens* has potential to be harvested for wood on five (or less than five) year rotations (vigour and wood quality are likely to decline beyond this period). Trees around this age should attain a dbh in the range of 10–15 cm. To achieve this, spacing of plants may be a critical factor and therefore trials are warranted to investigate this effect. (Judging from our field observations of natural stands we would expect that, under cultivation, plants could be grown reasonably close together without detrimental effect to growth form or the quantity of woody biomass produced.)

Root suckering is unlikely to pose problems in the management of this species as a phase crop. However, *A. decurrens* produces prolific quantities of seed which would result in the creation of a soil seed bank that could lead to weed problems in adjacent or subsequent annual crops. (Alternatively young seedlings may possibly be treated as a form of green manure.) Harvesting plants before they reach biological maturity is one way of preventing seed set; however, plants would need to have developed sufficient wood biomass by that time for such a technique to be viable.

The area predicted to be climatically suitable for the cultivation of *A. decurrens,* based on its natural climatic parameters, is shown in Map 18. This analysis indicates that *A. decurrens* has the potential to be cultivated in regions well beyond its natural distribution, extending into the greater than 600 mm rainfall zones of Victoria, Tasmania, South Australia and Western Australia. However, within the both the eastern and western target zones the best results will probably be achieved on valley soils on upland sites that receive a minimum of 500 mm mean annual rainfall. The species should also tolerate frosty winter conditions fairly well so sites at higher altitudes should be targeted. However, provenance variation is likely to affect its success in cultivation, particularly for growth and drought tolerance. The species is susceptible to borer attack and control of insects and fungal pathogens could be important silvicultural issues.

Acacia decurrens has environmental weed potential, particularly in high rainfall areas. It is not known, however, if it would be a problem in the drier environment of the target area. Nevertheless, any wide-scale use of this species should be accompanied by a thorough weed risk assessment.