Department of **Agriculture and Fisheries**
Biosecurity Queensland

Broad-leaved paspalum

Paspalum mandiocanum

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Front cover: *Paspalum mandiocanum*.

Photo: Sheldon Navie.

Contents

Summary

Paspalum mandiocanum (broad-leaved paspalum) is a subtropical grass native to South America. It was first imported into Australia in the 1960s as a potential pasture plant and was probably first planted in this country in the 1970s. Until recently it was largely known as *Paspalum wettsteinii* in Australia, but this name was wrongly applied.

Following pasture trials, a cultivar was released commercially under the name *P. wettsteinii* 'Warral'. This cultivar has been planted in northern New South Wales and Queensland, but has been found to be unpalatable to cattle in certain situations. Further experimental planting was undertaken in Queensland and northern New South Wales in the 1990s to evaluate its potential use as a ground cover for planting in shaded areas under mature macadamia trees.

Currently, *P. mandiocanum* has naturalised on the Atherton Tablelands in North Queensland and at numerous locations scattered across coastal south-east Queensland and northern New South Wales.

Climatically, *P. mandiocanum* prefers subtropical areas where annual rainfall exceeds 1000 mm. While it grows most prolifically in open, unshaded sites such as pastures (open grasslands), roadsides, forest gaps and margins, it can readily persist in deep shade, such as areas under forest canopies.

While this study was unable to find published evidence that *P. mandiocanum* is a significant weed overseas, there is clear evidence that its abundance and distribution are increasing in mesic habitats in coastal south-east Queensland, on the Atherton Tablelands, and in coastal north-east New South Wales. At some sites it is considered to be a potentially serious environmental weed and an unpalatable weed of pastures. Moreover, some landowners are concerned that it might become a serious pest of pastures in moist upland habitats of south-east Queensland (e.g. in the Sunshine Coast hinterland) and eastern areas of the Atherton Tablelands.

Important note: Please send any additional information, or advice on errors, to the authors.

Identity and taxonomy

Species	*Paspalum mandiocanum Trin.*
Common names	broad-leaved paspalum, broad leaf paspalum, broad leafed paspalum, paspalum, warral grass, warrel grass
Synonyms	*Paspalum wettsteinii* Hack is often misapplied as a synonym.

Family: Poaceae.

The genus *Paspalum* comprises 350–400 species that are largely endemic to the tropical and subtropical regions of the world (Jarret et al. 1998; Zuloaga, 2003), with a centre of diversity in South America (Fernandes et al. 1974; Jarret et al. 1998).

Paspalum mandiocanum comprises two varieties, *P. mandiocanum* var. *mandiocanum* and *P. mandiocanum* var. *subaequiglume*. Chromosome counts are 2n = 50 for var. *mandiocanum* and 2n = 60 for var. *subaequiglume* (Pozzoboni et al. 2008). However, these varieties are not currently recognised by botanists in Australia (Bostock and Holland, 2007).

Taxonomic uncertainty

Until recently, this species was often known by the name *Paspalum wettsteinii* in Australia. Many of the early introductions were given this name, and a commercial cultivar was released under the *Paspalum wettsteinii* 'Warral' (Partridge, 2003; DPI&F, 2007).

Recent taxonomic study has shown that the type specimen of *Paspalum wettsteinii* is actually *Paspalum virgatum*, and that the species to which the name '*Paspalum wettsteinii*' has been attached in Australia is really *Paspalum mandiocanum* (Bryan Simon, pers. comm.).

This name change was instituted by the Queensland Herbarium by 2002 (Henderson, 2002), has been widely taken up in this state. However, *Paspalum mandiocanum* is still largely referred to as *Paspalum wettsteinii* in New South Wales, including on the New South Wales flora website (PlantNET, 2009).

Description

The following description is derived from Sharp and Simon (2002), Navie and Adkins (2008), Clayton et al. (2009) and PlantNET (2009).

Paspalum mandiocanum is a summer growing, perennial grass with a weakly clumped growth habit (Figure 1). It can grow up to 1 m tall, but is generally less than 50 cm in height. When growing in shaded areas in macadamia orchards, it grows to a maximum height of approximately 20 cm (not including taller seed heads). Clumps are up to 1 m wide. While not strongly stoloniferous, the lower parts of the stems produce roots where they contact the ground, resulting in the radial spread of clumps. Its flowering stems (i.e. culms) are decumbent and 45–125 cm long. Culm internodes are distally glabrous.

Figure 1. Clumping habit of *Paspalum mandiocanum* (Photo: Sheldon Navie).

The leaves consist of a leaf sheath, which encloses the stem, and a spreading leaf blade. The leaf sheaths are somewhat pubescent, particularly near where they join to the leaf blade. Leaf blades are lanceolate, 10–30 cm long and 8–20 mm wide, with broadly rounded bases and acute apices (Figure 2). Their surfaces are glabrous and their margins are ciliate. The ligule is an eciliate membrane, about 1 mm long.

Figure 2. Base of the leaf blade of *Paspalum mandiocanum* (Photo: Sheldon Navie).

The seed head is quite typical for the genus *Paspalum*, with 3 to 10 branches (i.e. racemes) on a stem raised 15–20 cm above the vegetative growth (Figure 3). Each of these racemes are 3–10 cm long and have a tuft of hairs at their base. The numerous flower spikelets are borne in pairs, but are packed into four indistinct rows (Figure 4).

Figure 3. *Paspalum mandiocanum* seed head (Photo: Sheldon Navie).

Figure 4. *Paspalum mandiocanum* flower spikelets borne in four rows along the seed head branches (Photo: Sheldon Navie).

Flower spikelets comprise one or two glumes, a basal sterile floret and one fertile floret. They are elliptic, dorsally compressed, glabrous, and plano-convex (2–2.3 mm long and about 1.5 mm wide). The lower glume is absent or obscure while the upper glume is the length of the spikelet. Basal sterile florets are poorly developed, consisting of a lemma and an insignificant palea. Fertile florets consist of a lemma, palea, three stamens and an ovary topped with a feathery two-branched stigma. The fruit is a caryopsis. It remains enclosed within the mature flower spikelet, which is shed entire when mature (Figure 5).

Native range and worldwide distribution

Paspalum mandiocanum is native to the sub-tropical parts of South America, including southern Brazil (i.e. Rio Grande do Sul, Goiás, Minas Gerais, Paraná, Rio de Janeiro and Santa Catarina), northern Argentina (i.e. Tucumán, Corrientes and Misiones), Paraguay and Uruguay (GRIN, 2009; MBG, 2009). It has also been recorded on at least one occasion in Bolivia and Peru (MBG, 2009).

Figure 5. Close-up of *Paspalum mandiocanum* seed head with mature spikelets (Photo: Sheldon Navie).

This species has also been introduced into the USA (i.e. Georgia), Australia, Papua New Guinea and Indonesia for forage purposes (EPA, 2009; GBIF, 2009; MBG, 2009). Its known worldwide distribution is provided in Figure 6.

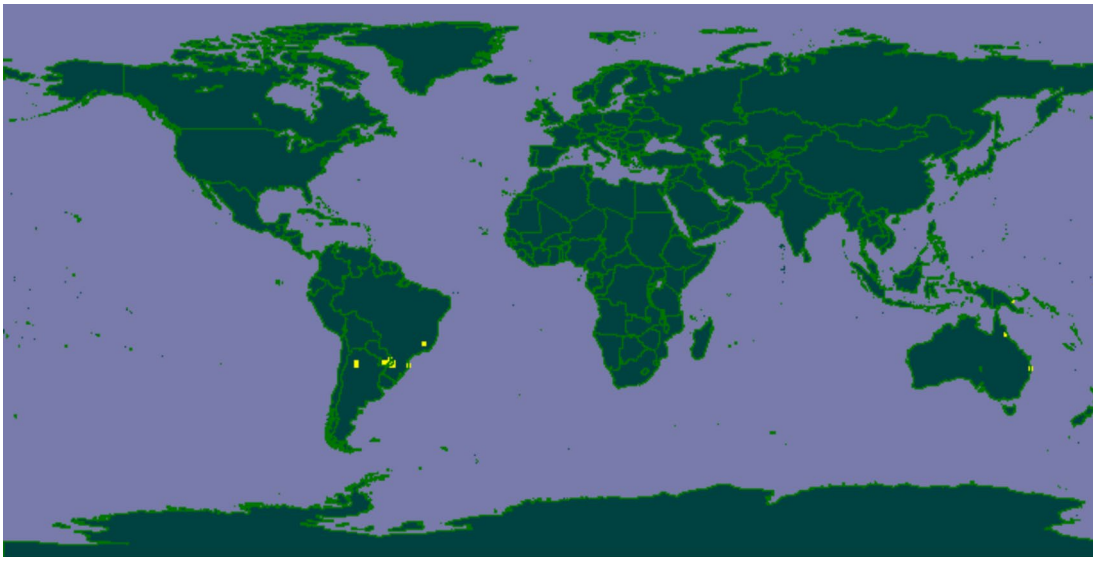

Figure 6. Distribution of *Paspalum mandiocanum* (source: GBIF, 2009).

Distribution in Queensland and Australia

Pasapalum mandiocanum has been recorded in coastal south-east Queensland, on the Atherton Tablelands in northern Queensland, once in coastal central Queensland, and in the coastal districts of eastern New South Wales (AVH, 2009; EPA, 2009; PlantNET, 2009). It is also naturalised on Lord Howe Island.

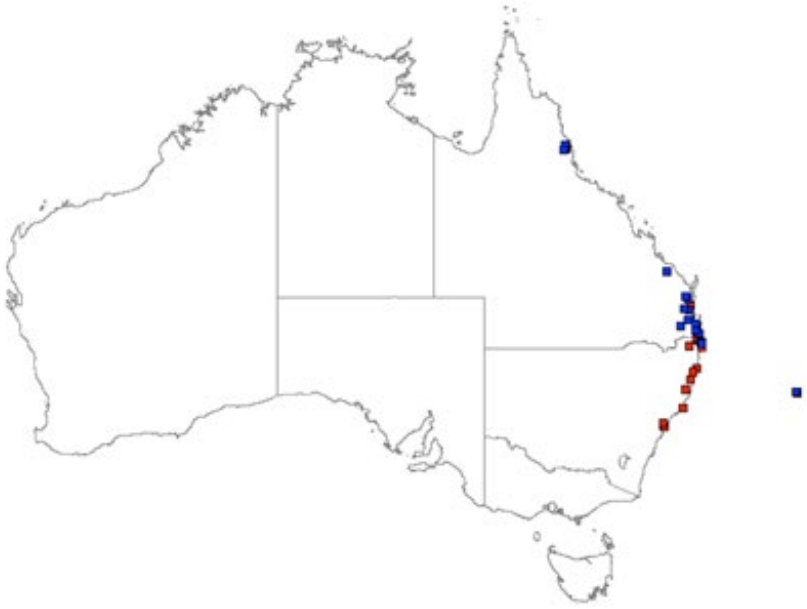

Figure 7. Distribution of *Paspalum mandiocanum in Australia (AVH, 2009).*

Note: records in red indicate specimens still recorded on the database as *Paspalum wettsteinii*.

It is most common in parts of Brisbane and surrounding areas (including lowland areas and upland areas around Mount Glorious), in the Gold Coast hinterland (e.g. on Mount Tamborine), and in the Sunshine Coast hinterland (e.g. around Maleny, Bellthorpe and Booroobin, including Bellthorpe State Forest and Reserves) (B. Mackenzie pers. comm; Navie and Adkins, 2008). It is also common in north-east New South Wales, with scattered populations extending southwards in coastal districts as far south as Gosford (PlantNET, 2009).

History of introduction into Queensland

Paspalum mandiocanum was first imported into Australia by Ron Williams (CSIRO Division of Tropical Agriculture, Brisbane) from the National Fisheries Station, Vacaria, Rio Grande do Sul, Brazil in 1965 for evaluation as a pasture species. It was originally collected from Guiba, Rio Grande do Sul, Brazil (Lat 27˚ 35' S, 48˚ 31' W). However, it was not released as a pasture species. Instead, it was recommended as a shade-adapted species that could be useful as a ground-cover in orchards by Dick Jones, CSIRO Division of Tropical Agriculture and Bruce Cook, Queensland Primary Industries and Fisheries.

According to the QPastures database (DPI&F, 2008b), two accessions (CPI 39969 and CPI 40520) were planted in Queensland as part of species evaluation trials; the first at Galloway Plains, Lochwall, Narayen (CSIRO), Oxford Downs, Springmount, Walkamin Research Station and Wolvi; the second at Galloway Plains, Lochwall, Narayen, Oxford Downs, Springmount and Wolvi; with trials ending between 1994 and 2001 depending on location. The starting date of these trials is unclear, but herbarium records indicate that both of these accessions were being grown in the Samford CSIRO Research Station Nursery in 1981 (EPA, 2009). Anecdotes suggest that some trials may have started as early as the 1970s.

Between 1996 and 2002, accession number CPI 39969 was evaluated by New South Wales Agriculture as a potential ground-cover species for planting under mature macadamia orchards in subtropical northern New South Wales.

This species was also introduced into Australia under the name *Paspalum wettsteinii*. The cultivar 'Warral' was developed as a pasture grass and released in New South Wales in the 1960s (DPI&F, 2007). It was subsequently used as a pasture for dairy cattle in Queensland; however, it seems to be much less palatable to cattle in this state (DPI&F, 2007).

Due to confusion over its taxonomy, the earliest records of this species in Australia were reported under the name *Paspalum wettsteinii*. The first herbarium record of it becoming naturalised in Queensland was in 1979, with volunteer plants being reported in a sown pasture east of Lowmead, in the Port Curtis district (EPA, 2009). The first herbarium record in south-eastern Queensland was in 1990, at Mulgowie near Gatton. This was followed by records at Alexandra Hills, in Brisbane, and at 'Glenwood', near Gympie, in the following 12 months. In 1993, it was reported in pastures in the Currumbin Valley and occurring along the banks of the Pimpama River at Ormeau (EPA, 2009).

Paspalum mandiocanum was first recorded in northern Queensland in 1992, as a common grass growing with *Elephantopus mollis* in an overgrown pasture at Millaa Millaa (EPA, 2009). This collection was made as part of the Northern Australia Quarantine Strategy (NAQS) program, and may be the first occasion where the species was thought to be potentially invasive. In 2001 and 2002, there were further reports of unwanted naturalised populations from dairy cattle paddocks on the Atherton Tablelands (ISC, 2003; CRCAWM, 2006).

In recent years it has been reported: along a horse trail on the edge of rainforest at Mount Nebo in 1999; on horticultural properties around Bellthorpe in 2000; invading pastures in the pastures in the Topaz area and along roadsides in the Tamborine National Park in 2001; on the bank of Kedron Brook in Ferny Grove in 2002; growing on swales between coastal sand dunes on Fraser Island in 2003; in Brisbane Forest Park, from grazing and horticultural properties around Booroobin and on roadsides and pastures around the Blackall Range region in 2004 (DPI&F, 2008a; EPA, 2009).

Preferred climate

After reviewing information on the native range of *P. mandiocanum*, this study suggests that this species is best adapted to subtropical areas, but can extend into the margins of tropical and warm temperate areas. While this study was unable to find detailed data on this species' climatic requirements, field observations in Queensland suggest that it is best suited to climates where rainfall is in the order of 1000–2000 mm per annum.

Ecology and preferred habitat

In regularly burned grasslands of southern Brazil, where *P. mandiocanum* is native, it has been collected from plots at the forest-grassland border (Overbeck et al. 2006). In Sao Paulo State, Brazil, *P. mandiocanum* has been recorded from shaded sites within a vegetation formation described as 'upland forest' (Klink and Joly, 1989). Elsewhere in its native range, it has been recorded growing along shaded forest edges, as well as from open ground (Firth, 2001).

Field observations in Queensland confirm that this species is capable of growing in both shaded and unshaded sites, since it has been recorded from unshaded pastures and roadsides, semi-shaded riparian areas and forest margins and deeply shaded areas of forest. Firth et al. (2002) found that *P. mandiocanum* was one of only a few species that survived under low light conditions beneath macadamia trees in northern New South Wales. However, biomass production was still greatest under high light conditions (3708 kg dry matter after one year in high light conditions, compared with 88 kg dry matter after two years under low light conditions). Hence, while *P. mandiocanum* can persist in deeply shaded habitats, it grows more prolifically in unshaded sites.

Paspalum mandiocanum is almost always found in mesic (i.e. moist) habitats. For example, on the Gold Coast (coastal south-east Queensland) it occurs in disturbed areas of moist forest (Searle, 2005). Similarly, it has been found in damp sites along the edges of watercourses, forests and in pastures, generally in areas that experience annual rainfall in the order of 1000–2000 mm (e.g. Mount Tamborine, Mount Glorious, Maleny and the eastern Atherton Tablelands).

Reproduction and dispersal

Paspalum mandiocanum reproduces from seeds that are produced in considerable numbers in late summer. When cultivated in pure stands, seed production equivalent to 615 kg/ha has been recorded from autumn-harvested experimental plots at Walkamin (Atherton Tablelands). As a spring-harvest is possible, an annual seed yield of 1 tonne/ha is feasible (Cox, pers. comm.). *Paspalum mandiocanum* is considered to produce more seeds than *P. notatum* (Firth, 2001).

Seed viability is high in the first year and germination occurs readily. Up to 150 seedlings/m^2 have been recorded within a shaded macadamia orchard in northern New South Wales (Firth et al. 1999).

Field observations in New South Wales suggest that seeds are mostly dispersed by water and farm machinery (Firth, 2001). Some of the early records in Queensland occurred in recently sown pastures, indicating that it may have been spread in contaminated pasture seed lots. Plants have been observed to escape sown plots readily with naturalised specimens recorded 50 m down-slope from sown plots after only two years. Similarly, naturalised specimens have been seen in relatively high numbers on a relatively bare, shaded orchard floor within 100 m of sown plots, with isolated plants found 500 m away after four years (Firth, 2001). In south-east Queensland, roadside mowing equipment has been blamed for its rapid dispersal.

History as a weed overseas and interstate

This study was unable to find published evidence that *P. mandiocanum* is a significant weed overseas. However, it has become invasive in eastern New South Wales and on Lord Howe Island.

In New South Wales, where it is still largely known by the name *Paspalum wettsteinii*, it is quite widespread. The first record of it becoming naturalised in New South Wales was unable to be established by this study, but it was recorded at Mummulgum on the New South Wales North Coast as early as 1991 (PlantNET, 2009). *The Flora of New South Wales*, published in 1993, noted that it was naturalised north from the Wauchope district (Harden, 1993). While it is still mostly found in the North Coast region, it has spread significantly and has also been recorded on a few occasions in the Central Coast region (i.e. north of Sydney).

Impact

Current impact in Queensland

Paspalum mandiocanum is not a declared plant in Queensland. However, it is invasive and is rapidly increasing in abundance and range in coastal south-east Queensland. At some sites it has formed virtually pure stands that appear to be suppressing or replacing other groundcover vegetation. In fact, it was recently ranked among the 100 most invasive plants in south-east Queensland (Batianoff and Butler, 2002).

The rate of spread of *P. mandiocanum* in coastal south-east Queensland appears to be rapid. Despite only being first planted in experimental plots at various sites in Queensland possibly as early as the 1970s, by 2008 it has spread to numerous locations across coastal south-east Queensland. As an example, it was first detected near Maleny north of Brisbane in 2002, but by 2008 some 150 sites were documented (EPA, 2009; B. Mackenzie pers. comm.).

Its ability to grow in heavy shade under a tree canopy means it has the potential to become an environmental weed in mesic forests and perhaps the edges of rainforests. *Paspalum mandiocanum* has already been recorded from conservation areas on the Gold Coast (e.g. the Tugun Hill Conservation Area, the Clagiraba Conservation Area and Springbrook National Park) and appears to be altering the ecology of those areas where it becomes established (Searle, 2005).

Figure 8. Dense *Paspalum mandiocanum* infestation along a roadside in the Natural Bridge section of Springbrook National Park (Photo: Sheldon Navie).

When growing in pastures, *P. mandiocanum* provides little value as a source of feed for cattle or horses and is considered to be unpalatable. When conditions are favourable, it can form a dense ground cover, replacing less competitive pasture grasses. This is causing concern among graziers, particularly in the Maleny area of south-east Queensland where it has been observed to replace kikuyu (B. McKenzie pers. comm.). Similarly, there is increasing concern that this species could become an unwanted and unproductive pest on grazing land in the higher rainfall eastern areas of the Atherton Tablelands in North Queensland.

Paspalum mandiocanum is not known to be a weed of crops.

Potential impact in Queensland

Based on an assessment of the native range and preferred habitats of *P. mandiocanum*, this species is predicted to become more abundant within shaded and unshaded mesic sites in coastal, subtropical areas of south-east Queensland, higher rainfall eastern parts of the Atherton Tablelands, and coastal north-east New South Wales, in areas where annual rainfall is between 1000–1500 mm. A prediction of areas where climate appears suitable for *P. mandiocanum* is shown in Figure 9.

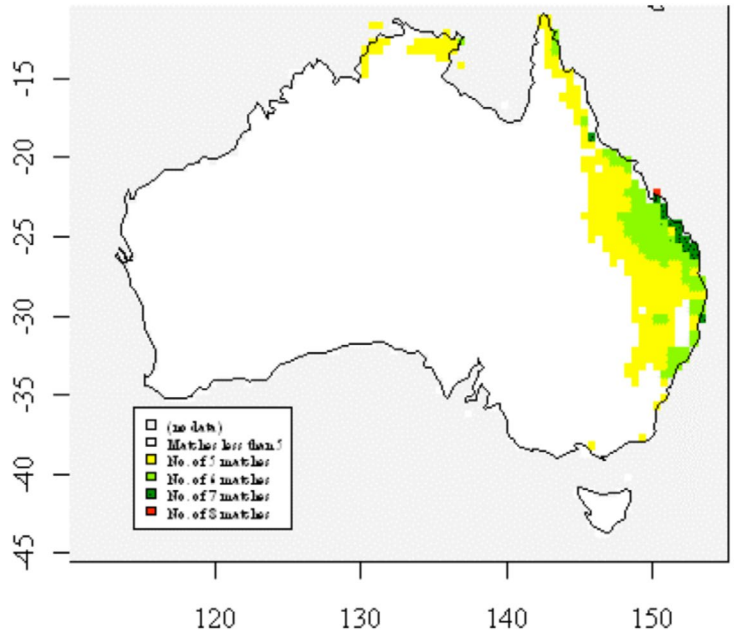

Figure 9. Potential distribution of *Paspalum mandiocanum*, as predicted by CLIMATE computer software (dark green indicates areas where climate is considered most suitable, light green indicates marginal suitability and yellow and white unsuitable).

Introduced grasses in general are emerging as insidious and poorly recognised threats to native biodiversity. For example, there is concern that *P. mandiocanum* might be posing a long-term threat to two endangered species in northern New South Wales, Floyd's grass (*Alexfloydia repens*) and the black grassdart butterfly (*Ocybadistes knightorum*). The larvae of black grassdart butterfly only feed on Floyd's grass, which is restricted to several small areas threatened by development and weeds, especially *P. mandiocanum*, lantana, groundsel and asparagus fern (NSW Scientific Committee, 2002; Navie and Adkins, 2008).

Paspalum mandiocanum is also reported to be dominating the understorey and inhibiting natural regeneration in paperbark wetland communities in the Belongil Wetlands at Byron Bay; hence it may also pose a threat to the long-term survival of entire plant communities (Navie and Adkins, 2008).

Uses

As mentioned earlier, a cultivar of this species (under the name *Paspalum wettsteinii* 'Warral') has been planted as a forage grass in north-eastern New South Wales and Queensland. However, it seems to be much less palatable to cattle in Queensland and is often brought into Queensland Primary Industries and Fisheries offices for identification, as it is not being eaten by cattle (DPI&F, 2007).

Analyses of the feed quality of *P. mandiocanum* indicated crude protein of 16.5%, digestibility of 59.5%, and metabolisable energy of 8.5 MJ/kg dry matter (Firth, 2001). While relatively nutritious for grazing animals, palatability is poor.

Paspalum mandiocanum was also planted in experimental plots in Queensland and northern New South Wales in the 1990s to evaluate its potential use as a ground cover for planting in shaded soil under tree crops such as macadamias. Because of its shade tolerance, the planting of *P. mandiocanum* was also suggested as a way of controlling *Drymaria cordata* (tropical chickweed), a troublesome ground-covering weed under commercial macadamia crops in northern New South Wales (Firth, 2001).

Paspalum mandiocanum was planted in four evaluation trials over a five-year period on krasnozem soils in northern New South Wales. The first trials were in macadamia orchards at Wollongbar and Rosebank near Lismore from 1996–98. Up to 28 legume and grass species or accessions were evaluated to obtain suitable low-growing perennial groundcovers. A report was published on this work (Firth et al. 1999).

Paspalum mandiocanum tolerates regular mowing and may have some value as a lawn species.

Control

Small numbers of seedlings and small plants can be removed by hand. However, chemical control is required for large infestations (DPI&F, 2008a).

Experimental control work has been undertaken on a dairy property near Millaa Millaa and at the DPI&F (now QPIF) research station at Walkamin. Initial experiments testing selective grass herbicides were unsatisfactory. Subsequent trials using atrazine during the pasture establishment phase worked well (DRDC, 2003).

There have not been any studies on the effect of fire on survival of *P. mandiocanum* in Australia. However, Overbeck et al. (2006) collected this species from regularly burnt grasslands, suggesting it is well adapted to survive episodic fire. Moreover, field observations near Maleny (south-east Queensland) suggest that this species can become evident following bushfires (B. Mackenzie pers. comm.).

Pests and diseases

While some species of *Paspalum* are susceptible to ergot fungus on their seed heads, experience to date indicates that *P. mandiocanum* is not susceptible to ergot (Firth, 2001).

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