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A REVIEW OF *DIGITARIA DIDACTYLA* WILLD., A LOW-INPUT WARM-SEASON TURFGRASS IN AUSTRALIA: BIOLOGY, ADAPTATION AND MANAGEMENT

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ABSTRACT

Digitaria didactyla Willd. (blue couch) is a warm-season turfgrass well adapted to use in low maintenance lawns, parks and golf fairways on well-drained acid infertile light-textured soils in humid subtropical and tropical climates with mild winters and an absence of heavy frosting. In Australia, *D. didactyla* includes material from two different genetic sources: Queensland blue couch from widely naturalised material accidentally introduced from the Mascarene Islands or Madagascar in the early 19th century; and Swazigrass from deliberate introductions of the former *D. swazilandensis* (native to mainland southern Africa) in the mid-1960s. Two cultivars, 'Aussiblue' and 'Tropika', derived from Swazigrass germplasm have been released in the past 20 years. Blue couch is less drought hardy than *Cynodon dactylon* (L.) Pers., but recovers quickly once drought stress is removed. It is tolerant of temporary, though not permanent, waterlogging, but has a low tolerance of salinity. While Queensland blue couch is among the least shade tolerant warm-season turfgrass species, Swazigrass does tolerate moderate levels of shading. Propagation is usually by vegetative means, though limited supplies of Queensland blue couch seed are also available. Blue couch has a low fertility requirement, and can invade and replace *C. dactylon* under low nutrition on acid infertile soils. It is prone to iron deficiency, especially after heavy rainfall. Blue couch is lower thatching and less prone to scalping than *C. dactylon*, but is also less tolerant of wear than the latter. Lawn armyworm and sod webworm caterpillars are the main pests, with dollar spot the major disease of concern. Most standard broadleaf herbicides can be safely used with blue couch, and fluazifop has shown promise for selective control of other grasses.

INTRODUCTION

Digitaria didactyla Willd. is a warm-season turfgrass well adapted to use in low maintenance lawns on infertile acid sandy and other light-textured soils. It is frequently grown, sometimes accidentally, as a domestic lawn, in parks and on golf courses throughout the tropics and subtropics in southern Africa, southern and south-east Asia, and Australia (Maiden, 1910; Bor, 1960; Veldkamp, 1973; Webster, 1983; Gibbs-Russell et al., 1990), but not in the USA where its use has not progressed beyond a long history of experimental sowings in Florida (Piper, 1923, 1924; Laird, 1930; Wipff, 2003). This would account for its omission from leading turf textbooks produced in the US (e.g. Beard, 1973; Duble, 1996; Pessarakli, 2008; Christians, 2011), with the exception of a first brief mention in Turgeon's (2011) Ninth Edition.

In Australia, *D. didactyla* includes material from two distinctly different genetic sources. The first of these is the widely naturalised material derived from an accidental introduction from the Mascarene Islands in the early 19th century, and commonly referred to as "Queensland blue couch". The second source was a series of deliberate introductions of *D. swazilandensis* (now regarded as conspecific with *D. didactyla*), commonly known as Swazigrass, from southern Africa in the mid-1960s. In this paper, we have retained the above common names to distinguish genetic material from these two different sources, and use "blue couch" when referring to the overall *D. didactyla* complex. Other common names used for *D. didactyla* include serangoon grass (Skerman and Riveros, 1990; Uddin et al., 2011), sarangoon grass (Lee, 1986), blue serangoon grass and green serangoon grass (Cook et al., 2005) in Malaysia, petit gazon in Mauritius (Cook et al., 2005), and Swaziland finger grass in South Africa (Chippindall, 1955; Gibbs Russell et al., 1990).

Despite its widespread use, either deliberately or as a naturalised species, technical information on *D. didactyla* remains poorly documented. Our aim in this paper is therefore to provide a comprehensive account of current knowledge in relation to the use of *D. didactyla* as a turfgrass in Australia, supplementing the published literature with personal observations and those of experienced practitioners as appropriate. In so doing, we are fully cognisant that some less formal information may, in time, need modification or even prove to be erroneous. Queensland blue couch and Swazigrass both have dual-purpose roles as forages and as turf grasses; but in the present context, we have included pasture-related information only where this contributes to a better understanding of *D. didactyla* in a wider sense. We have also deliberately excluded detailed reference to its use in other countries, particularly in Asia, where differences in climate may have led to significant genetic differences in the local ecotypes there. Nevertheless, it is timely to provide a sound knowledge base on which future studies of *D. didactyla* and its use as a low maintenance, low fertility turfgrass can be further developed.

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Abbreviations: NSW, New South Wales; QLD, Queensland; CPI, Commonwealth Plant Introduction number; MSMA, monosodium methanearsonate; DSMA, disodium methanearsonate

Keywords: Australia, adaptation, biology, blue couch, *Digitaria didactyla*, *Digitaria swazilandensis*, management, Queensland blue couch, Swazigrass

ORIGIN

The Queensland blue couch form of *D. didactyla* originates from the Mascarene Islands and Madagascar (Stapf, 1911; Bogdan, 1977; Skerman and Riveros, 1990). The habitat description with one Madagascan collection was "sandy dunes" (Stapf, 1911). Whether or not the natural distribution of this form extends to mainland southern Africa as suggested by Veldkamp (1973) is unclear, though unlikely: Chippindall (1955) makes no reference to *D. didactyla* in her classic work on South African grasses; and Henrard (1950) gave no locations for *D. didactyla* from mainland Africa, except for the var. *decalvata* which he described from a specimen collected in 1931 on Umbogintwini Experiment Station in Natal.

The description of the former *D. swazilandensis* in 1930 was based on specimens from Swaziland (Stent, 1930). Its natural distribution extends from Swaziland and KwaZulu-Natal to Limpopo Provinces in South Africa (Gibbs Russell et al., 1990; Germishuizen and Meyer, 2003), and into Mozambique and Malawi (Goetghebeur and Van der Veken, 1989). It is cultivated in Zimbabwe (Bennett, 1980), but does not occur naturally there (B.K. Simon, personal communication, 2012). The natural habitat of *D. swazilandensis* is described as "disturbed sandy soil" (Gibbs Russell et al., 1990) and as "grassland in open woodland clearings and on alluvial soil, disturbed areas and roadsides" (Goetghebeur and Van der Veken, 1989).

HISTORY AND USE IN AUSTRALIA

The first record of Queensland blue couch in Australia was a collection made by Dr Sieber in 1823 from Port Jackson (Sydney) (Stapf, 1911; Vickery, 1961). However, it was not until Maiden (1910) wrote in glowing terms of its performance as a turfgrass for lawns and greens in the Sydney (NSW) area that its value was recognised and the species became used more widely. Maiden initially identified the grass as a variety of *D. sanguinalis*, an error that was quickly corrected by Stapf (1911) who confirmed that it was indeed *D. didactyla*. At that time, it was known to have been growing in the Sydney Botanic Gardens and in the lawns of the adjacent Government House for at least 30 years. By 1915, it was being used on ordinary lawns, bowling-greens, tennis courts and croquet lawns where it was considered superior to *Cynodon dactylon* (L.) Pers. (Webster, 1983). In the early 20th century, it was highly regarded as a fairway grass on many Sydney golf courses; and in pre-bentgrass days, Queensland blue couch was present on many of their putting greens, but proved unsatisfactory for this purpose because of its frost sensitivity and subsequent browning off in winter (Black, 1939) though better suited under hotter, more humid conditions on the NSW north coast (Corbett, 1962; Halton, 1965). Nowadays, the main areas with Queensland blue couch in Sydney are in the warmer eastern suburbs where it is still used in lawns.

Under warmer winters than in Sydney, Queensland blue couch performed better on putting greens as well as on fairways in coastal Queensland, and was used on bowls greens. It was also commonly used for lawns (Smith, 1941). The first record of *D. didactyla* in Queensland was from a collection made "near Nudgee" (now a suburb of Brisbane) in 1906 (Bailey, 1913). Black (1939) gave the first collection site as "Nundah" (which is close to Nudgee), and stated that its subsequent spread had been very rapid, particularly in the previous 20 years. By the mid-1930s, the Queensland Board of Greenkeeping Research (1935b, 1936d) was able to state that it was the best known and most extensively used turfgrass for golf course purposes, and provided detailed information on the establishment and maintenance of Queensland blue couch putting greens. At that time, the prestigious Royal Queensland Golf Club, for example, had a 60:40 mixture of *D. didactyla* and *C. dactylon* (Russell, 1936), and has retained its distinctive Queensland blue couch fairways into the 21st century. Queensland blue couch is also present in fairways on many lower maintenance golf courses along the Queensland coast as far north as Cairns and Cooktown. However, it was superseded for greens purposes by the finer-textured hybrid bermudagrasses (*Cynodon dactylon* (L.) Pers. x *C. transvaalensis* Burtt-Davy) 'Tifdwarf' and 'Tifgreen' after they were imported and became available in the late 1960s and 1970s. Queensland blue couch was grown on lawn tennis courts at the old state tennis centre at Milton, but has been superseded for that purpose by *C. dactylon* (J.W. Hume, personal communication, 2012).

In the Petrie district north of Brisbane, Blake (1939) observed that Queensland blue couch appeared following clearing of the open eucalypt forest vegetation and formed an almost complete cover on totally cleared ground, except in very damp situations. It was also commonly found along roadsides. Queensland blue couch is now widely naturalised on well-drained sandy or loamy soils through coastal southern and central Queensland where it constitutes a significant grazing resource (Loch and Ferguson, 1999). It seeds prolifically from late spring through to early autumn (November-March), and transfer by grazing animals through seeds in dung is a major factor facilitating the spread of the species (Jones et al., 1991).

Queensland blue couch has been used as a minor species for lawns in the Perth area of Western Australia. It has also been used successfully in Darwin and other coastal areas in the Northern Territory for household lawns and for intensive use on golf fairways, golf greens and bowling greens (Cameron, 2006). Based on herbarium records, its naturalised distribution across Australia, and including Lord Howe Island to the east, is shown in Plate 1.

In contrast to the accidental introduction and spread of Queensland blue couch, the introduction, testing and subsequent dissemination of Swazigrass in Australia have been quite deliberate. In addition to a very early introduction (CPI 8493) which proved to be coarse, stemmy and unattractive for both forage and turf use, five morphologically similar accessions of *D. swazilandensis* were introduced in 1966 from the University of the West Indies collection in Trinidad. Vegetatively-propagated single seedling plants derived from four of these lines (CPI 40639, CPI 40673, CPI 40674 and CPI 40676) were later included in pasture trials in southern Queensland and northern NSW. Because Swazi grass produces higher forage yields than Queensland blue couch, work since 1999 has been directed towards developing a synthetic forage variety that can be propagated commercially from seed (Campbell and Officer, 2009). At the same time, two vegetatively-propagated turf varieties have been released.

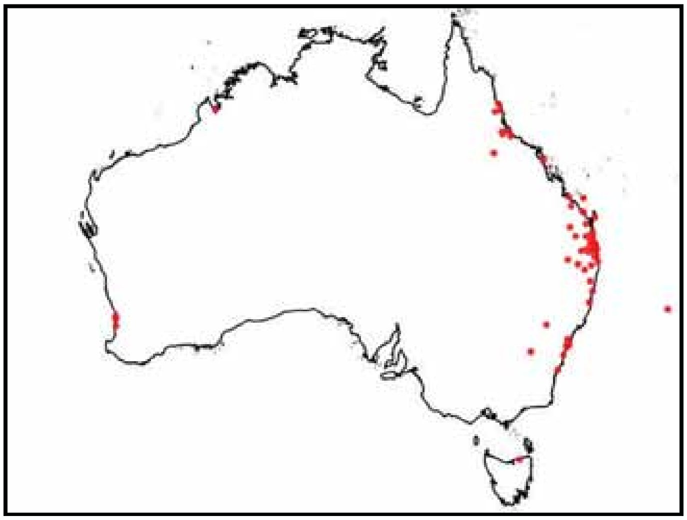

Plate 1. Naturalised distribution of *Digitaria didactyla* in Australia based on herbarium records (Source: Australia's Virtual Herbarium http://avh.ala.org.au/, created 11 July 2012).

TAXONOMY

Taxonomically, the genus *Digitaria* Haller is placed in the subfamily Panicoideae (tribe Paniceae), and comprises more than 200 described species mainly from tropical and warm temperate regions (±200 species - Clayton and Renvoize, 1982; 220 species - Watson and Dallwitz, 1992 onwards; ±230 species - Clayton and Renvoize, 1986; Goetghebeur and Van der Veken, 1989; 261 species - Clayton et al., 2006 onwards; about 200-330 species – Quattrocchi, 2006; 277 species – Simon et al., 2011 onwards). There is considerable diversity both between and within *Digitaria* species, which may be annual or perennial, with or without rhizomes, with or without stolons, and tufted (erect) or decumbent or sometimes prostrate (sward/mat forming). The genus is extremely variable with regard to inflorescence structure, relative length of spikelet scales, and spikelet indumentum types, with different combinations of appressed pubescence, glassy bristles and marginal cilia possible within the same species or even between the two members of a spikelet pair. Despite this, the overall facies of the spikelet is surprisingly uniform, and the genus is seldom difficult to recognise (Clayton and Renvoize, 1986).

The name *Digitaria* is derived from the Latin *digitus* (finger), alluding to radiating inflorescence branches (e.g. Watson and Dallwitz, 1992 onwards; Quattrocchi 2006). Hence, *Digitaria* species are collectively called "finger grasses". The genus includes minor cereals from west Africa (*D. exilis* (Kippist) Stapf, *D. iburua* Stapf) and south Asia (*D. compacta* (Roth) Veldkamp, *D. cruciata* (Nees ex Steud.) A. Camus), important pasture grasses (*D. eriantha* Steud., *D. milanjiana* (Rendle) Stapf), turf grasses (*D. didactyla* Willd., *D. diversinervis* (Nees) Stapf), and a number of weedy species (Veldkamp, 1973; Clayton and Renvoize, 1986; Watson and Dallwitz, 1992 onwards; Quattrocchi, 2006; Missouri Botanical Garden, 2012). Holm et al. (1977) lists the annual *D. sanguinalis* (L.) Scop. (crabgrass) and the perennial *D. abyssinica* (Hochst. ex A. Rich.) Stapf (as *D. scalarum* (Schweinf.) Chiov.) among the world's 100 worst weeds. Other weedy annual *Digitaria* species include *D ciliaris* (Retz.) Koeler (but also used as a forage and hay crop – Loch and Ferguson, 1999; Beck et al., 2007), *D. ischaemum* (Schreb.) Muhl., *D. ternata* (Hochst. ex A. Rich.) Stapf, and *D. violascens* Link (Holm et al., 1977, 1979; Tothill and Hacker, 1983; Watson and Dallwitz, 1992 onwards; Randall, 2002; Sharp and Simon, 2002; Quattrocchi, 2006; Simon and Alfonso 2011 onwards). *Digitaria* species are often found on infertile soils (which aids the competitiveness of the many weedy species), while the perennial *D. connivens* (Trin.) Henrard, for example, can colonise sandy beaches (Clayton and Renvoize, 1986; Quattrocchi, 2006).

With so many species (>200), it is convenient to divide such a large diverse genus into groups; but, while most *Digitaria* species can be placed into natural groups (i.e. subgenera and sections) that share taxonomically important characteristics, Webster (1983) found that, when the full range of taxa is considered to enable relationships among groups to be interpreted, the current groups intergrade, making it difficult to describe each of these consistently. The current infra-generic groupings are based largely on the treatment of Henrard (1950) with modifications by Veldkamp (1973) and de Agrasar (1974), but do not seem to reflect the true relationships within the genus (Webster, 1983; Clayton and Renvoize, 1986). Instead, recognition of these categories should be based on overall biological similarity rather than a select few characters, but will first require a detailed study of the variation at species level on a world scale. Based on a recent study of phylogeny in the tribe Paniceae by Morrone et al. (2012), the genus *Digitaria* appears to be monophyletic.

D. didactyla falls within Henrard's (1950) Section *Erianthae* (maintained by Veldkamp, 1973, but not by de Agrasar, 1974) along with the robust African perennials *D. eriantha* and *D. milanjiana* (Webster, 1983). The species name *didactyla* is derived from the Greek *dis* (twice) and *daktylos* (finger), referring to an inflorescence with two racemes (Sharp and Simon, 2002), though the raceme number can vary within and between regional ecotypes. *D. swazilandensis* Stent (native to mainland southern Africa) was originally described as a separate species (Stent, 1930), but was reduced to synonymy with *D. didactyla* by Kok (1984) (*cf.* Clayton and Renvoize, 1982; Goetghebeur and Van der Veken, 1989) and is now treated as conspecific with *D. didactyla* (Gibbs Russell et al., 1990; Missouri Botanical Garden, 2012). It is also closely related to *D. diversinervis* (Richmond grass), another mat-forming southern African grass used for lawns, particularly in shaded areas (Chippindall, 1955; Gibbs Russell et al., 1990).

MORPHOLOGY

The following morphological description is largely derived from Sharp and Simon (2002) and Clayton et al. (2006 onwards). The line drawing in Plate 2 illustrates these attributes for the Queensland blue couch form. Genotypes from the former *D. swazilandensis* typically have somewhat coarser leaves (broader, longer) and also form a denser, more tightly matted sward than the original Queensland blue couch.

Plate 2. Morphological characteristics of *Digitaria didactyla* (Queensland blue couch form): **A** Plant (X 0.5 magnification) showing prostrate to decumbent habit; **B** Stolon (X 1.3) with simple nodes; **C** Membranous ligule (X 7); **D** Digitate inflorescence (X 1.8); **E** Raceme (part) showing arrangement of spikelets (X 14); **F-J** Spikelet parts (X 21); **F** Lower glume; **G** Upper glume; **H** Lemma (lower floret); **I** Palea (lower floret); **J** Fertile upper floret. (Drawing: W. Smith; copyright retained by the Queensland Herbarium).

Habit. Perennial, mat forming. Stolons present; simple nodes as described by Bogdan (1952), each with only one subtending leaf. Culms decumbent or prostrate, 10–60 cm tall, 1–5-noded. Mid-culm internodes glabrous. Mid-culm nodes brown, glabrous. Leaf-sheaths smooth or scaberulous, glabrous on surface or hairy. Leaf-sheath auricles absent. Ligule an eciliate membrane, 0.8 mm long. Leaf-blades flat or conduplicate, 2–6(–10) cm long, 1–6 mm wide, glaucous. Leaf-blade surface smooth, glabrous or hairy. Leaf-blade margins smooth or scaberulous.

Inflorescence. Inflorescence digitate, with racemose branches. Racemes 2–3(–4); paired or digitate; unilateral; 3–10 cm long. Rhachis wingless or narrowly winged, with sharp-edged midrib, angular, 0.6 mm wide, smooth on surface, scaberulous on margins. Spikelet packing imbricate.

Spikelets. Spikelets pedicelled, 2 in the cluster. Pedicels terete or angular, unequal, 0.15–2.5 mm long, scabrous, tip widened. Fertile spikelets 2-flowered, the lower floret barren (rarely male), the upper fertile, without rhachilla extension, lanceolate or oblong, dorsally compressed, (2.0–)2.2–2.7 mm long, falling entire. Rhachilla internodes brief up to lowest fertile floret.

Glumes. Glumes two; dissimilar, shorter than spikelet; thinner than fertile lemma. Lower glume ovate, 0.2–0.4 mm long, 10% of length of spikelet, membranous, 0-nerved. Lower glume lateral veins absent; apex truncate. Upper glume ovate; apex acute; dorsally convex in profile; 1.3–1.6 mm long, 33–50% of length of spikelet; membranous, upper surface indumented; without keels; 3-nerved.

Florets. Basal sterile floret 1, without significant palea. Lemma of lower sterile floret lanceolate, 2.3–2.7 mm long, 100% of length of spikelet, membranous, 5–7-nerved, with nerves free at apex, smooth or scaberulous, rough on nerves, pubescent, acute. Fertile lemma lanceolate, 2.0–2.7 mm long, cartilaginous, much thinner on margins, yellow or light brown. Lemma surface striate. Lemma margins flat, covering most of palea. Lemma apex acute, muticous or mucronate. Palea cartilaginous. Lodicules present.

Distinguishing Morphological Characteristics. For those not familiar with *D. didactyla* and *C. dactylon*, which can appear very similar in leaf texture, identifying the two species in the field can prove difficult, particularly from poorly developed or damaged specimens; mixed swards also commonly occur. Differences in ligule structure – membranous in *D. didactyla* compared with *C. dactylon* where the ligule consists of a dense row of short hairs on a membranous rim – are frequently used by greenkeepers and other practitioners. Another useful morphological difference is the structure of their stolon nodes: simple with one subtending leaf in *D. didactyla* (see Plate 2); compound with 3 subtending leaves in *C. dactylon*.

GENETIC VARIATION

Published chromosome counts consistently report 2n = 18 chromosomes for *D. didactyla* (Darlington and Wylie, 1955; Tateoka, 1965) and the former *D. swazilandensis* (Moffett and Hurcombe, 1949). Gupta et al. (1974) also found a hexaploid *D. swazilandensis* (2n = 54), while Bogdan (1977) reported a tetraploid count of 2n = 36 chromosomes for *D. didactyla*, but gave no details as to the origin of this.

While there appear to be no reports on the reproductive breeding system in *D. didactyla*, the variation seen in spaced plant studies and in progeny of selected plants is consistent with a sexual outbreeding mode of reproduction in both Queensland blue couch and Swazigrass. At Redlands Research Station (Cleveland, QLD), 540 Swazigrass seedlings from CPI 40674 and 512 plants of Queensland blue couch from two commercial seed sources and from vegetative collections from closely mown golf greens showed considerable variation in habit and morphology among spaced plants of both types (D.S. Loch, unpublished data, 2000-12). Overall, Queensland blue couch plants that had survived and thrived in closely mown greens were denser, more prostrate in habit, had finer-textured leaves, and produced fewer inflorescences than those grown from commercial seed. Similarly, Campbell and Officer (2009) at Grafton (NSW) reported differences in seed and dry matter yields in comparisons between single-plant clones and with their progeny.

No selected cultivars of Queensland blue couch have been developed, though commercial ecotypes from different environments can differ in some attributes. For example, commercial turf produced in subtropical Queensland shows very poor winter colour retention compared with local strains in Sydney (NSW), even without being subjected to frost (P. McMaugh, unpublished observations, 1970-2012). In Sydney, leaf morphology varies, with shorter, narrower leaves near the coast compared with strains in western Sydney. Genotypes with the typical, more bluish green, leaf colour also appear to be associated with poorer winter colour retention. Given the prolific seeding normally seen on Queensland blue couch during summer, it would be virtually impossible to exclude seedling contamination of a vegetatively-propagated variety, though a seed-propagated synthetic variety should be more feasible to maintain.

Two single-clone Swazigrass varieties have been released, both with much less prolific inflorescence production during summer than Queensland blue couch. Both are vegetatively propagated.

- ‘Aussiblue’ (based on a selected seedling from CPI 40639) was commercialised in 1998 and is a proprietary variety protected under Australian Plant Breeder’s Rights legislation (Scattini, 2001). Compared with Queensland blue couch, it is more robust in appearance with broader, lighter coloured, less bluish-green leaves, and fewer but larger inflorescences. It spreads more rapidly by stolons, and forms a denser, more easily maintained sward.
- ‘Tropika’ is a public variety commercialised in the mid-1990s by Tropical Lawns Pty Ltd in north Queensland (T.A. Anderlini, personal communication, 2012). It was derived from a seedling of unknown origin growing at the Department of Primary Industries, Mareeba (QLD); this differed from known material of the 4 accessions then being distributed experimentally. Compared with Aussiblue, Tropika has slightly broader leaves that are darker blue-green in colour.

ENVIRONMENTAL ADAPTATION

Temperature. Blue couch is best adapted to areas not subjected to heavy frosts, which quickly cause browning off (Black, 1939; Stanley and Ross, 1989). Its effective southern limits as a useful turfgrass are warmer parts of the central NSW coast around Sydney (mean monthly average temperature 17.8°C – Australian Bureau of Meteorology, 2012) and Perth in Western Australia (mean monthly average temperature 18.2°C – Australian Bureau of Meteorology, 2012). If not frosted, blue couch will continue to grow through the winter at a faster rate than other warm-season turfgrasses. This was documented by Loch and Pearce (2012) for Aussiblue Swazigrass in experiments conducted in Brisbane (QLD), comparing its relative dry matter yields in four growth cycles (35-42 d) from early autumn through to mid-winter with those of other warm-season turfgrasses. Aussiblue maintained >40% of its maximum growth rate into the 2010 winter and >30% in the slightly cooler 2011 winter compared with 16% or less for *Cynodon dactylon*, *Eremochloa ophiuroides* (Munro) Hack. (centipedegrass), *Stenotaphrum secundatum* (Walter) Kuntze (St Augustinegrass), *Zoysia japonica* Steud. and *Zoysia matrella* (L.) Merr. (zoysiagrasses) (Table 1). Similarly, in a pasture cutting trial at Samford (QLD), Strickland (1973) reported that the winter dry matter production from Queensland blue couch was three times that of three *Cynodon* accessions.

Soils. As indicated earlier, blue couch grows best on deep sandy and loamy soils; it is not suited to heavy clay soils (Maiden, 1910; Ginns, 1936; Queensland Board of Greenkeeping Research, 1936b, 1936d; Cameron, 2006). Such soils are typically acid and low in fertility, with strong growth of blue couch seen even on strongly acid soils (pH5.0-5.5), lower in pH than considered desirable for *Cynodon* spp. (R. Pinkerton, personal communication, 2012).

Soil Moisture. Blue couch is less tolerant of extreme and prolonged drought periods than *C. dactylon* (Maiden, 1910; R. Pinkerton, personal communication, 2012). Studies by Zhou et al. (2012) in shallow lysimeters with limited soil depth showed that, during the dry-down phase, blue couch was a higher water user and had a shorter survival period before 100% leaf firing than *C. dactylon* and *S. secundatum*, and ranked similarly to *Paspalum vaginatum* Sw. (seashore paspalum) for these attributes. Perhaps significantly, Queensland blue couch wilts more rapidly than other grasses, including Swazigrass (D.S. Loch, unpublished observations 2000-12), which would then drastically reduce further water loss through transpiration. However, following a significant rainfall event or irrigation, droughted blue couch can recover rapidly from the apparently dead crowns, giving full turf cover again within weeks (Maiden, 1910; Loch, 2007 - see also Plate 3); in contrast, drought-damaged swards of *S. secundatum* and *P. vaginatum* are much slower to recover (D.S. Loch, unpublished observations 2000-12). In naturalised pasture situations in particular, post-drought recovery of Queensland blue couch is also aided by seedling recruitment from the soil seedbank. For these reasons, blue couch is well adapted to the level of drought experienced in Brisbane and other parts of coastal Queensland where it is mainly used and widely naturalised, provided the depth of soil that can be exploited by its roots gives sufficient water storage capacity (Loch, 2007). Similarly, Queensland blue couch pastures on shallower hillside soils are less productive than on deeper soils (Smith, 1941).

At the other extreme, blue couch is tolerant of temporary, but not permanent, waterlogging (R. Pinkerton, personal communication, 2012). It will also tolerate short-term inundation; but where flooding is accompanied by silt deposition, survival of short recently-mown turf is better than with longer tillers that are more prone to being pushed over and buried by even a shallow 1-2cm layer of silt (Loch and Pearce, 2012). Nevertheless, it is virtually impossible to keep Queensland blue couch free of grass weeds in areas subject to occasional flooding (P. McMaugh, unpublished observations, 1970-2012).

Table 1 Mean and minimum temperatures (T) and relative dry matter yields for four growing periods from early autumn through to mid-winter in Brisbane, Australia. (Source: Loch and Pearce 2012)

Year	**2010**				**2011**			
Growing Period	**4 Mar-6 Apr**	**7 Apr-10 May**	**11 May-15 Jun**	**16 Jun-20 Jul**	**18 Feb-25 Mar**	**26 Mar-28 Apr**	**29 Apr-9 Jun**	**10 Jun-19 Jul**
Temperature (°C)								
T_{mean}	25.1	22.7	17.1	15.7	25.8	22.3	17.1	14.3
T_{min}	19.3	17.2	12.7	11.1	20.5	17.5	12.4	9.4
Relative dry matter yields†								
Digitaria didactyla	1.000	0.746	0.415	0.453	1.000	0.474	0.306	0.314
Cynodon dactylon	1.000	0.452	0.293	0.125	1.000	0.940	0.334	0.135
Stenotaphrum secundatum	1.000	0.620	0.224	0.163	1.000	0.597	0.282	0.158
Zoysia japonica	1.000	0.612	0.158	0.119	1.000	0.972	0.053	0.005
Zoysia matrella	1.000	0.803	0.102	0.123	1.000	0.764	0.036	0.012
Eremochloa ophiuroides	1.000	0.705	0.141	0.011	1.000	0.566	0.186	0.071

†Maximum = 1.000

Plate 3. An apparently dead patch of Queensland blue couch *(top)* almost completely recovered 10 days after a significant rainfall event *(bottom)* (after Loch 2007).

Salinity Tolerance. Both Queensland blue couch and Aussiblue Swazigrass showed very low tolerance of salinity in hydroponic screening and field experiments by Loch et al. (2006). While it is possible that other ecotypes of Queensland blue couch may have evolved with higher salinity tolerance, there are no anecdotal reports to support this. In this respect, it is noteworthy that *D. didactyla* (Serangoon grass) was ranked among the least tolerant group in salinity studies by Uddin et al. (2011).

Shade Tolerance. Queensland blue couch fails completely under even moderate levels of shade (Wilson, 1997). Its response to shade is to etiolate, producing reduced numbers of elongated tillers with long narrow near-vertical leaves that intercept only a minimal amount of incident light. This also allows prostrate weeds to invade and dominate the stand. Swazigrass, however, shows more shade tolerance than Queensland blue couch, but is probably still no more than moderately shade tolerant. At Redlands Research Station (Cleveland, QLD), plots of Aussiblue Swazigrass grown under 55% shade survived and maintained acceptable turf quality, while plots of Queensland blue couch deteriorated, became thin and weed-infested, and required periodic replacement (D.S. Loch, unpublished data, 2000-12).

Photoperiod. No detailed research has been reported for blue couch in relation to the factors that control flowering. However, the late spring through to autumn (mainly November to April) flowering behaviour of Queensland blue couch in the field is consistent with a long-day response (D.S. Loch, unpublished observations, 2000-13). There appears to be perhaps some variation in the qualitative-quantitative intensity of this response among individual plants and populations such that minor differences in flowering time may be seen within and between ecotypes.

SEED PRODUCTION AND QUALITY OF QUEENSLAND BLUE COUCH

Seed of Queensland blue couch was available in the 1930s; but at that time, the Queensland Board of Greenkeeping Research (1935b) cautioned against its use to establish new areas because of very low seed quality (<5% germination). However, Febles-Perez et al. (1974) took two harvests of seed with a sickle-bar mower, each yielding approximately 100 kg/ha of seed after threshing and cleaning. After allowing 14-24 months to remove any post-harvest dormancy, germination tests with light and alternating temperature regimes typical of those used with other warm-season grass seeds gave around 80% and 40% germination for the first and second crops, respectively. The harvested seed also retained its viability for at least 2 years in sealed storage at 15°C as intact spikelets, but a dehulling treatment markedly reduced germination from both harvests, probably through damage to the caryopses.

The work by Febles-Perez et al. (1974) subsequently led to a resumption of production of Queensland blue couch seed by up to 3 specialist growers over the past 20 years or so. However, this has remained on a limited scale, and there are currently two commercial growers still producing Queensland blue couch seed, one on a fertile red volcanic krasnozem soil on the Atherton Tablelands of far north Queensland (G.W. Poggioli, personal communication, 2012) and the other on an infertile poorly-drained Wallum soil (consisting of a shallow ~30 cm sandy layer over clay and rock) in the Wide Bay region of coastal southern Queensland (T.W. Hall, personal communication, 2012). Both growers fertilise to start their seed crops by the end of October (spring), though this can be up to a month earlier in southern Queensland depending on seasonal conditions. The amount of fertiliser N used on established paddocks varies from 55-85 kg N/ha on the fertile soil to c. 140 kg N/ha on the infertile soil. Depending on the starting date, seed crops may be harvested in late December, though January is more usual. Both growers mow the ripe seed crop, and then pick it up from the windrow with a combine harvester 1-3 days after mowing unless delayed further by wet weather. Excessive rainfall during the summer wet season can lead to crop failures. While this also precludes attempting a second crop in north Queensland, a second crop is possible in southern Queensland, starting in late January (mid-summer) for a seed harvest in May (late autumn).

PRODUCTION OF VEGETATIVE TURF SOD

Maintaining good soil moisture consistently throughout the production cycle is critical for the production of strongly rooted blue couch turf sod (R. Pinkerton, personal communication, 2012). This requires regular irrigation to supplement rainfall received; if blue couch is allowed to dry out at any stage, root development invariably becomes weaker, leading to increased breakage (and wastage) of turf rolls during harvest. At that point, it is necessary to strip the dead mat layer back (e.g. with a forage harvester or Topmaker®) so that the plants can shoot from the base and re-grow again with a stronger root system

Because blue couch is a stoloniferous rather than a rhizomatous species, a narrow rill should be left between the bare soil strips where turf rolls have been harvested (R. Pinkerton, personal communication, 2012). When the area is around 75% grown back in, these can be removed with a forage harvester or Topmaker to leave an even surface for the next harvest. The application of chicken litter (widely used by Australian turf growers) at the start of a new growth cycle is advantageous in helping to develop strong rooting. In the early stages of regrowth while there is a lot of bare ground, a good practice is to use a readily soluble N fertiliser like urea to avoid the risk that the less readily soluble components of a complete NPK blended fertiliser could be washed to the lowest parts of the paddock during heavy rain, It typically takes around 10-12 months (perhaps a little less if starting after winter) from one harvest to the next to produce Queensland blue couch sod ready for sale, and around 8-9 months to produce saleable Swazigrass sod. However, there is a higher mowing requirement to dress Swazigrass sod up ready for sale.

Commercial production of high quality Queensland blue couch sod is difficult in areas where there is a high population of naturalised *C. dactylon* (P. McMaugh, unpublished observations, 1970-2012). Manual rogueing and spot-spraying with glyphosate have previously been used to remove *C. dactylon* and other grass weeds from blue couch, with bare spot-sprayed patches of Queensland blue couch able to fill in from seedling recruitment around February-March (R. Pinkerton, personal communication, 2012). In the future, however, fluazifop offers promise as a selective grass herbicide for this purpose (Loch and Pearce, 2012).

ESTABLISHMENT

To lay an instant, fully-covered lawn using roll-out blue couch sod, the same principles apply as with other turf species in this situation (R. Pinkerton, personal communication, 2012). Preparation should begin with a minimum of 10-15 cm depth of well-drained sandy loam underlay soil to provide adequate moisture storage and enable strong root development to support the above-ground turf. Depending on soil fertility at the site, a blended fertiliser (high N, low P and moderate K) should be spread to a maximum of 50 kg N/ha and raked into the top centimetre or so of the underlay. After pre-watering, the sod should then be rolled out onto cool moist underlay soil, watered well again immediately after laying, and then sprinkled regularly until sufficiently rooted down into the underlay soil, at which time light mowing can commence (normally after about 4-6 weeks). Alternatively, plugs, sprigs, stolons or pieces of turf can be planted at close regular spacings through the prepared area, and allowed to grow in gradually to form a full sward (Queensland Board of Greenkeeping Research, 1935b, 1936d; Cameron, 2006). Light topdressing can be used to correct surface levels, taking care not to smother the grass underneath (R. Pinkerton, personal communication, 2012).

Lawns sown from seed also take time to germinate and for the seedlings to develop into a mature established sward. Recommendations are based on those used with *C. dactylon*, with high seeding rates (1-2 kg per 100 m^2 – M.J. Dunn, personal communication, 2012) broadcast onto the surface of a fine firm seedbed, lightly covered at most, and rolled.

TURF MANAGEMENT

Nutrition. Nitrogen (N) is the main nutrient that drives grass growth. Based on their N requirements, grasses can be classed as low, medium or high fertility species. Low fertility grasses, for example, tend to dominate the sward a low levels of soil available N while medium and high fertility grasses become more productive and dominant as N levels rise.

Blue couch is tolerant of low fertility conditions, but is also responsive to added fertiliser N. In an experiment on an infertile yellow Kurosol soil at Redlands Research Station (Cleveland, QLD), Aussiblue Swazigrass with optimum requirements around 100-200 kg N/ha/year was less fertility demanding than the other 5 grasses studied (Loch et al., 2006). It maintained good turf quality, density and colour at these N rates while minimising dry matter production and hence mowing requirements. Aussiblue resisted invasion by other grasses, even in the zero N treatment, but was still quite responsive to N rates up to 400 kg N/ha/year in terms of dry matter production. In earlier pasture trials, Henzell (1963) noted, in relation to the closely related Queensland blue couch, that while it dominated his unfertilised sward it also responded to fertiliser N in terms of increased dry matter production. Similarly, Menzel and Broomhall (2006) found that Queensland blue couch growing in large containers of sand was more responsive in terms of dry matter than other low fertility species (e.g. *E. ophiuroides*). At the Royal Queensland Golf Club, Queensland blue couch fairways receive a complete fertiliser (including c. 80 kg N/ha) in October-November, followed by regular but much smaller amounts of liquid N fertiliser through irrigation to top this up over the remainder of the growing season (K.M. Hyland and M.A. Price, personal communication, 2012).

Iron deficiency is frequently seen as a yellowing of the leaves in Queensland blue couch and (to a lesser extent) Swazigrass. This typically occurs after rain, possibly due to a temporary loss of some of the feeder roots. Hunter (2002) showed that this can be corrected by applying a foliar spray of ferrous sulphate at a rate of 3.75 g per 5 m^2. His results also suggested that the symptoms could be minimised by developing a deep, healthy root system.

Irrigation. In subtropical areas like Brisbane and the southern Queensland coast, there is usually sufficient out-of-season rainfall to ensure the survival of blue couch with little or no irrigation, provided there is sufficient topsoil depth to store the necessary water. Where irrigation is required to maintain higher quality turf, deep watering at less frequent intervals is preferred to develop a deeper, more resilient root system. However, in more monsoonal climates like the Top End of the Northern Territory, regular dry season watering is essential to avoid an extremely parched, dried-out look (Cameron, 2006).

Mowing. For general-purpose lawns, the optimum mowing height for blue couch is around 25-30 mm (R. Pinkerton and T.A. Anderlini, personal communication, 2012). Once it is well established, however, Queensland blue couch on more intensively managed fairways can be taken down to 10-12 mm to form a denser, finer-textured playing surface (K.M. Hyland and M.A. Price, personal communication, 2012). Past experience has also shown that even lower mowing heights (5 mm or less) are possible on golf and bowls greens and tennis courts with Queensland blue couch, particularly the more prostrate genotypes, although it is no longer used for these purposes (J.W. Hume, personal communication, 2012; P. McMaugh, unpublished observations, 1970-2012). However, Queensland blue couch grown from commercial seed requires frequent mowing throughout the active growing season to remove inflorescences, thus keeping it in an aesthetically acceptable condition.

Blue couch is lower thatching and less prone to scalping than *C. dactylon*, but will recover quicker should this occur (R. Pinkerton and T.A. Anderlini, personal communication, 2012). It should not be mown when damp (i.e. early morning, after rain) because the moist clippings will cling together and not be distributed evenly or picked up properly. Mowing should be avoided on shaded areas of Queensland blue couch during winter (K.M. Hyland, personal communication, 2012), though recent experience suggests that trinexapac-ethyl reduces etiolation enabling shaded areas to be mown normally during winter (M.A. Price, personal communication, 2012).

Like *C. dactylon*, pollen dispersal by Queensland blue couch during seeding adds to the allergenic pollen load in the atmosphere in Brisbane (QLD) during summer (Moss, 1965). Regular mowing to remove inflorescences before they flower helps lessen this risk.

Playing Quality and Wear Tolerance. While the low thatching ability of Queensland blue couch relative to *C. dactylon* means that golf balls do not sit as high on the underlying sward (P. McMaugh, unpublished observations, 1970-2012), this does not present a significant problem on well-managed fairways (K.M. Hyland and M.A. Price, personal communication, 2012). Because it forms a denser turf, Swazigrass gives higher traction readings (comparable to *C. dactylon*) than Queensland blue couch (Roche et al., 2007), and is preferred when used deliberately on sportsfields. Blue couch is less wear tolerant than *C. dactylon* (Roche et al., 2012), mainly due to poor wear resistance; but it does recover rapidly from wear.

Pests. Blue couch is attacked by a number of different pests, all of which can also affect other grasses. By far the most serious of these for blue couch are the lawn caterpillar complex (colloquially referred to as "lawn grubs"), which consist of armyworms and/or sod webworm (*Herpetogramma licarsisalis* (Walker) Lepidoptera: Pyralidae) larvae (Champ, 1955; Elder, 1976; Broadley, 1978, 1979; Common, 1990). The main armyworm species that affects turf grasses is the lawn armyworm (*Spodoptera mauritia* (Boisduval) Lepidoptera: Noctuidae), but there are also four other armyworm species that may attack turfgrasses occasionally or in different districts. Armyworms and sod webworm both feed opportunistically on a wide range of other grasses, including *C. dactylon* (Grant, 1982), but prefer grass from more fertile areas. Armyworm larvae hide during the day in the basal thatch layer and come out at night to feed on the leaves, thereby defoliating patches of an infested lawn (Swaine and Ironside, 1983). The sod webworm also defoliates the lawn by night leaving the denuded stems; and by day each caterpillar lives among the grass roots and debris at the soil surface in a silk-lined tube made of leaves from food plants. In both cases, most of the damage is done by the larger maturing larvae (i.e. about the last two instars), and damage is most severe in late summer and autumn after the depleted over-wintering populations have been through enough life cycles to build up sufficient numbers again. Depending on seasonal conditions, lawn caterpillars reach plague proportions only in some years and the composition of the complex may also vary from year to year (Smith, 1933; May and Passlow, 1954; Champ, 1954). During severe outbreaks, parasitic native ichneumon wasps (*Lissopimpla excelsa* (Costa) Hymenoptera: Ichneumonidae) can be seen flying low over an infested lawn seeking armyworm larvae, and large faecal pellets from sod webworms can be seen at the base of the webbed leaves (Swaine and Ironside, 1983). Alternatively, larvae will congregate on the surface beneath a wet bag (or old towel) left out overnight.

Scarab beetle larvae occasionally damage the roots of blue couch, but are not serious pests. Outbreaks on golf courses in the 1930s were identified as black beetle (*Metanastes vulgivagus* (Olliff) Coleoptera: Scarabaeidae) (Queensland Board of Greenkeeping Research, 1935a), a native species, but nowadays the similar, but slightly smaller, exotic African black beetle (*Heteronychus arator* (Fabricius) Coleoptera: Scarabaeidae) is more common in general turf situations.

A grass mealybug called the felted coccid (*Antonina graminis* (Maskell) Hemiptera: Pseudococcidae) is widely distributed in Queensland, and affects >70 grass species in Australia and >130 worldwide, including both forms of blue couch (Brimblecombe, 1966, 1968; Ben-Dov, 1994). Felted coccid infestations weaken and stunt, rather than kill, the host plant, reducing shoot numbers and turf quality; but insect numbers can reduced in the field, probably by an unidentified parasitoid wasp (D.S. Loch, unpublished observations, 1988-2012). Three species of parasitoid wasps are known to exert biological control over felted coccid infestations overseas (Questel and Genung, 1957; Dean et al., 1979; Frank and McCoy, 2007), none of which is confirmed as present in Australia. However, there are parasitoids present that are related to *Anagyrus antoninae* Timberlake (Hymenoptera: Encyrtidae), one of the previously identified biological control agents, such as the native *Anagyrus fusciventris* (Girault) (Australian National Insect Collection, 2012) and the introduced *Anagyrus saccharicola* Timberlake (Carver et al., 1987).

The grass-webbing mites, *Oligonychus araneum* Davis and *O. digitatus* Davis (Tetranychidae: Acarina), are native species described by Davis (1966, 1968). They occasionally form conspicuous webbed patches over the leafy surfaces of a range of pasture and turf grasses, including blue couch, usually under dry conditions, and are often found together in the same infestation (Gutierrez and Schicha, 1983). An early example of such an infestation on a fairway appears to have been erroneously ascribed to red spider mite by the Queensland Board of Greenkeeping Research (1936c). Recently, McMaugh et al. (2011) also found a false spider mite, a species of *Dolichotetranychus* Sayed (Tenuipalpidae: Acarina), on Queensland blue couch, but more work is needed to determine the full identification and significance of this species in relation to blue couch.

Nematodes are not generally perceived as causing problems with blue couch. Nevertheless, Colbran (1964) listed 14 nematode species associated with the roots of Queensland blue couch as a host plant in Queensland.

Diseases. Fungi associated with disease symptoms in blue couch and recorded in the Australian Plant Pest Database are listed in Table 2, showing current species names updated by R.G. Shivas (personal communication, 2012). The main disease of concern with blue couch is dollar spot (R. Pinkerton, personal communication, 2012) caused by *Sclerotinia homoeocarpa*. The first record of dollar spot in Australia came from a specimen of Queensland blue couch in 1934 (Reilly, 1969). It is a disease more common in low fertility situations, so the fact that blue couch is a low fertility species and that most blue couch lawns receive little or no fertiliser N could perhaps be exacerbating the effects of the disease in this context.

Brown patch (caused by *Rhizoctonia* sp.) on Queensland blue couch was of concern to the Queensland Board of Greenkeeping Research (1936a, 1936d), and this or related diseases also affect other warm-season turfgrasses and seem to be more prevalent in wet years. There is also a range of other fungi (*Bipolaris*, *Colletototrichum*, *Curvularia*, *Magnaporthe*, *Passalora*, *Stemphylium* spp.) associated with leaf spots and leaf blight symptoms. Curvularia blight, for example, appears to have a more damaging effect on Swazigrass than on Queensland blue couch under stressful cold, wet conditions (D.S. Loch, unpublished observations, 1999). Slime mould (*Physarum cinereum* (Batsch) Pers. – non-pathogenic) is occasionally seen on blue couch during wet weather.

Three virus diseases have been reported, but do not appear to cause serious damage to blue couch. Teakle and Grylls (1973) recorded an aphid-transmitted virus of the Sugar-Cane Mosaic (SCMV) type on blue couch from both southern and northern Queensland. The symptoms of this strain are inconspicuous, such that infection may go unnoticed. Blue couch is the only known natural host of Digitaria Striate Mosaic Virus (DiSMV) also known as Digitaria Didactyla Striate Mosaic Virus (DDSMV), an Australian mastrevirus causing streak symptoms, which is transmitted by the leafhopper *Nesoclutha pallida* (Evans) (Hemiptera: Cicadellidae) (Greber, 1989; Persley and Greber, 2004; Briddon et al., 2010). Interestingly, Teakle et al. (1991) in glasshouse transmission trials found a Swazigrass genotype susceptible to the widespread Pangola Stunt Virus (PaSV) while Queensland blue couch remained uninfected.

Weed Control. When well grown with adequate soil N, blue couch forms a dense mat that resists weed invasion, particularly the Swazigrass genotypes (Cameron, 2006; Campbell and Officer, 2009). Blue couch tolerates a

Table 2. Fungi reported as associated with disease symptoms on *Digitaria didactyla* in Australia (Source: Australian Plant Pest Database; http://www.planthealthaustralia.com.au/go/phau/capacity-and-capability/information-support-systems/appd; 24 October 2012).

Disease/symptoms	Fungus
Dollar spot	*Sclerotinia homoeocarpa* F.T. Benn.
Leaf spots, leaf blight	*Bipolaris zeicola* Sivan.
	Bipolaris maydis (Y. Nisik. & C. Miyake) Shoemaker
	Colletotrichum caudatum (Sacc.) Peck
	Colletotrichum sublineola Henn. ex Sacc. & Trotter
	Curvularia brachyspora Boedijn
	Curvularia intermedia Boedijn
	Magnaporthe grisea (T.T. Hebert) M.E. Barr
	Passalora fusimaculans (G.F. Atk.) U. Braun & Crous
	Stemphylium sp.
Root rot	*Fusarium oxysporum* Schlecht.: Fr.
Root blight	*Pythium arrhenomanes* Drechsler
Brown patch/root and stem rot, leaf blight	*Rhizoctonia* sp.; *Thanatephorus cucumeris* (A.B. Frank) Donk

range of broadleaf herbicides, including 2,4-D, MCPA, dicamba, fluroxypyr, metsulfuron, trifloxysulfuron, and (in mixed products) mecoprop (Syngenta Crop Protection, 2011; R. Pinkerton and T.A. Anderlini, personal communication, 2012; D.S. Loch, unpublished data, 2000-12). While blue couch is susceptible to the organoarsenate herbicides MSMA (monosodium methanearsonate) and DSMA (disodium methanearsonate), recent trials by Loch and Pearce (2012) have shown Aussiblue Swazigrass to have useful tolerance to fluazifop, which could be used for the selective control of other grasses, particularly *Cynodon* spp., during sod production. The growth of Queensland blue couch is less affected by trinexapac-ethyl than that of *Cynodon* spp.; this difference has been exploited on mixed/contaminated fairways to give a competitive advantage to the Queensland blue couch (M.A. Price, personal communication, 2012).

CONCLUSIONS AND FUTURE PROSPECTS

In Australia, blue couch is well adapted to low maintenance turf use on well-drained infertile acid sandy and other light-textured soils in the humid subtropics and tropics with mild winters and no more than light frosts. While still the grass of choice in such areas (particularly for domestic lawns), blue couch nowadays is becoming less widely used even where it is clearly the best adapted species for the purpose. Reasons for this decline in the use of blue couch revolve around availability, price and publicity for alternative species (mainly *C. dactylon* and *S. secundatum*) versus blue couch.

Where *C. dactylon* (a high fertility species) is planted on low fertility soils and not fertilised adequately, it is usually replaced quickly, either partly or wholly, by blue couch (T.A. Anderlini, personal communication, 2012; D.S. Loch, unpublished observations, 2000-2012). *S. secundatum* also requires more fertile soils (or fertiliser N) than blue couch (Loch et al., 2006), and is not well suited to lawns in the sunny tropics and subtropics because it thatches badly (quickly becoming thick and spongy underfoot) and needs considerably more mowing and general management to keep it looking acceptable. Both *C. dactylon* and *S. secundatum* are now widely publicised (particularly the newer proprietary varieties), but without highlighting their weaknesses which need to be managed properly to maintain turf (and to maintain it in an acceptable condition).

C. dactylon is quicker (±6-month production cycle), easier to grow for sod producers, and more forgiving where consistent soil moisture is not maintained properly. In particular, the effectiveness of the organoarsenate herbicides in controlling other grasses, including blue couch, has been a significant advantage. However, with the imminent phasing out of the organoarsenates without a comparable replacement at this time, the balance could change in favour of blue couch with the availability of fluazifop for selective grass weed control and community aspirations for more environmentally friendly turf species requiring less fertiliser, less mowing and easier maintenance on low fertility soils.

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Digitaria didactyla Queensland blue couch. Eremochloa ophiuroides Centipede grass. Paspalum dilatatum Dallis grass.Â Warm season grasses. Bothriochloa macra Red grass. Chloris gayana Rhodes grass.Â The turfgrass manager needs to be able to identify the grasses that are being used in order to tailor the management to its characteristics. The manager also needs to be able to select the best grass for a particular site to ensure the most suitable combination for the needs of that site. Turfgrass identification commonly depends heavily on the reproductive characteristics of the plant but often the flower head, or inflorescence, has been removed in the mowing. Turfgrass has been shown to function efficiently as a means to reduce surface water runoff and can be used in conjunction with vegetative filter strips to provide a barrier against surface and groundwater contamination from pesticides and nutrients used on turf.Â In golf course management and sod production, a single application of simazine provides excellent broad-spectrum control of numerous winter annual species.Â There are about 14 warm-season (C4) species used for turfgrass purposes throughout the world.