Traffic Tolerance of Warm-Season Turfgrasses under Community Sportsfield Conditions

Matthew Roche
The Department of Agriculture, Fisheries and Forestry, QLD

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TU08018

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Traffic Tolerance of Warm-Season Turfgrass under Community Sportsfield Conditions

Final Report

Matt Roche *et al.*

Agri-Science Queensland, a service of the
Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ)

Project Number TU08018

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This report summarises the process and outcomes of a four year project, investigating (i) the effect of wear and (de-)compaction of different warm-season turfgrasses; and (ii) the mowing requirements of grasses primarily for sportsfield use following the application of the plant growth regulator trinexapac-ethyl. It also provides recommendations for further research and extension of project results.

This project has been funded by HAL using voluntary contributions from industry and matched funds from the Australian Government. Financial or in-kind support was provided by Redlands City Council, University of Queensland, sports turf and golfing associations, turf producers, fertiliser and pesticide companies and machinery companies. The diverse support to undertake the project signifies the wider turfgrass industries commitment to the quality and management of turfgrass in public open spaces, but more importantly at the grass roots level of community sport. A full list of participants can be seen on the subsequent page.

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Collaborators and Financial Contributors

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The organisations illustrated above include:

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~ Thank You ~

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Acknowledgements

The four-year Horticulture Australia (HAL) project is the first scientific study within Australia to assess simulated and actual wear studies of warm-season turfgrasses suitable for sportfield use. The study has allowed researchers and turf professionals to compare traffic (wear and compaction) tolerance and turf management requirements (e.g. mowing) of the current dominant varieties.

The study established trial areas established at Redlands Research Facility (RRF), Redlands Touch Association (RTA) and The University of Queensland (UQ). The latter sites were chosen and plots constructed following the support of their respective venue managers, turf producers, sports turf associations, and the Turf Industry Advisory Committee (IAC). The foresight of turf managers, including Laurence Blacka (Redland City Council), Darryl Hoffman (RTA) and Shane Biddle (UQ), should be commended for their involvement in the study and commitment to allow continued access to their fields for R&D purposes.

The financial and in-kind support to undertake the project was diverse and numerous including: Redlands Touch Association, Q Turf Machinery, Sports Turf Institute (Aust.), Sports Turf Association QLD Inc. (STA QLD), Sports Turf Association NSW Inc. (STA NSW), Sports Turf Association VIC Inc. (STA VIC), Australian Golf Course Superintendents Association (AGCSA), Golf Course Superintendents Association Queensland (GCSAQ), Golf Queensland, Sygenta Crop Protection Pty Ltd, Oz Tuff Turf, Australian Lawn Concepts, Dad and Dave's Turf, Evergreen Turf, Twin View Turf, Turf Force, Turf Solutions, Turf World, Caboolture Turf, Jimboomba Turf and Progressive Seeds.

A special mention should be given to Redland City Council, Redlands Touch Association and The University of Queensland who should be congratulated for their proactive approach in keeping the community's sportsfields safe and open. DAFFQ staff would also like to thank Terry Griffiths from Q Turf Machinery who continually made available his time and machinery to conduct routine decompaction treatments using a Verti-Drain machine.

A sincere thanks to former departmental technical staff Russ Clement, Tony Troughton and Mitch Wall, along with current DAFFQ technical staff Jon Penberthy and Lin O'Brien for their time and efforts spent collecting data, imposing wear and maintaining the RRF trial site.

The diverse support to conduct this project signifies the wider turfgrass industry's commitment to the quality and management of turfgrass in public open spaces, but more importantly at the grass roots level of community sport. By investing in turf research the results contained within this report will benefit not only community sporting clubs by members of the community which will enable continued sport participation and the opportunity to maintain a healthy lifestyle.

Matt Roche
Research Scientist – Turf
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Media Summary

A four-year study was conducted by the Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ) to primarily assess 'traffic stress' which includes soil compaction and turfgrass wear during use. Collectively, these stresses limit the amount of fixtures and training that can be made on these natural grass fields.

Trials were established at Redlands Research Facility (RRF) and at Redlands Touch Association (RTA) that enabled DAFFQ researchers to monitor the effects of simulated wear treatments against actual wear incurred from playing touch football. Following high usage, turf damage (wear) results showed that commonly used turf species such as green couch, blue couch and kikuyu varied as much as 89 %.

Following guidelines of >15 % wear (bare ground) is considered unfit for play; if kikuyu was planted on a community sportsfield, the field could be closed between 64-100 % of the season; whereas blue couch could see the venue shut between 2-90 %; and green couch could see between 0-65 % of field closures. Therefore the selection of a suitable turfgrass is vital. If chosen incorrectly, the ill performing playing surface could jeopardise club participation levels and the future of grass roots community sport.

A further case study site was established at The University of Queensland St Lucia campus following the devastating 2011 Brisbane floods. Three promising green couch varieties were selected from the RRF and RTA studies to be trialled against the old industry standard used for many sports turf installations. All varieties performed well following the high usage experienced as a result of a busy calendar year.

The project also investigated the performance of utilising a plant growth regulator (PGR) at varied rates to reduce mowing. The findings showed that turf managers applying PGRs at recommended rates have the ability to reduce mowing costs between 15 and 29 %. The long-term savings for sporting clubs in terms of resources (mowers, fuel, labour) is substantial. A reduced carbon footprint is an added bonus.

Findings obtained within the present study will assist community sporting groups who rely on the performance, including safety, of natural turf surfaces with solid information on which to base future turf installation and turf management decisions.

Technical Summary

After four years the Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ) community sportsfield studies have come to an end. Initially the study was to run for a period of two years; however, through industry consultation and support, the project was extended by two years to enable researchers to gather a minimum of two years replicated data from each of the three studies assessing ‘traffic stress’. The extension also provided DAFFQ researchers with an opportunity to undertake further testing across a range of warm-season grasses suitable for sportsfield, golf and/or recreational use.

To assess traffic stress, which is a combination or wear and compaction, wear studies were established at Redlands Research Facility (RRF) and at Redlands Touch Association (RTA) to monitor the effects of simulated wear treatments, using DAFFQ’s Wear Traffic Simulator, against actual wear incurred from playing touch football. Through undertaking comparative assessments of both facilities, results indicated that wear applied using the Traffic Simulator incurred 50 times more damage (wear) then that observed at the touch football fields (based on *Cynodon* spp. data only). However, the figures are relative and researchers are now aware of how many wear applications are required for future testing across turfgrasses being trialled to simulate touch football conditions.

Following 177 wear and turf quality assessments of plots within the simulated wear facility over a four year period results showed substantial differences in wear tolerance and recovery of grasses that are commonly used on community sportsfields. For example, if a sports club decided to choose between a commercially available variety of green couch (*Cynodon* spp.), blue couch (*Digitaria didactyla*) or kikuyu (*Pennisetum clandestinum*), field closures could vary as much as 89 % between species.

Following guidelines by McAuliffe and Roche (2009) of >15 % wear (bare ground) is considered unfit for play; if kikuyu was planted on a community sportsfield, the field could be closed between 64-100 % of the season; whereas blue couch could see the venue shut between 2-90 %; and green couch could see between 0-65 % of field closures. However, varietal difference was also vast, particularly within the green couch species of turf. Wear variation between 2 % and 90 % was observed of the green couches which are the primary selection of turf for planting on a sportsfield within sub-tropical and tropical environments.

Trials were established across 4 touch football field at the RTA. Each field played on average 1,454 games over a two-year period and on average only incurred approximately 4.9 % of wear (damage). The average wear was well under the 15 % bare ground recommendations and suggests that more fixtures could potentially be played across these fields in the future. However, inclement weather must be taken into consideration over the course of the playing season. Damage incurred from allowing games to continue following heavy rain caused significant damage to the turf surface resulting in 40 % to 80 % bare ground and compaction issues.

In an effort to relieve compaction, a mixture of irregular (annual and bi-annual) and frequent (6-weekly) verti-draining was conducted across the touch fields and surfaces hardness was monitored. Following 43 collective treatment applications conducted of the RTA and RRF trial sites between 2009 and 2012, no clear pattern in surface hardness reduction was observed. However, soil moisture did play a significant role in reducing surface hardness.

A case study site was established at The University of Queensland (UQ) St Lucia campus following the 2011 Brisbane floods to trail on a larger scale, unreplicated 1,500m² plots of three high wearing varieties of couch and an industry standard cv. Wintergreen. The case study played a significant part within the HAL funded study, as it provided researchers and industry alike to compare disseminated milestone results obtained from small replicated plots of the RRF and RTA studies with *in-situ* large scale plots undergoing actual use.

Wear tolerance and recovery capabilities of a turfgrass are important, yet so too are the mowing requirements. The morphological-agronomic diversity of C4 grasses is vast, but also within a species of turf significant variation exists, particularly between old and new varieties. Regular mowing improves turf quality; nevertheless it can be a financial burden on clubs resources and be very time consuming for turf managers during an active growing season.

Within the present study DAFFQ researchers assessed the performance of the plant growth regulator (PGR) trinexapac-ethyl (active constituent 120g/L) across 19 medium- to coarse-textured grasses suitable for sportsfield use. PGRs are used to reduce leaf and stem growth of a turf plant and inturn reduce mowing requirements. Results from the sportsfield suited grasses indicated that using trinexapac-ethyl could reduce mowing time between 15 to 29 % across the majority of the turfgrasses trialled.

Findings obtained within the present study will assist community sporting groups and turf managers who rely on the performance, including safety, of natural turf surfaces with solid information on which to base future turf installation and turf management decisions.

1. Introduction

"Traffic stress" is a general term that covers two components: soil compaction and wear (Beard, 1973). While soil compaction and wear may occur simultaneously on the same turf site, one is usually the dominant stress on the turfgrass plants (Carrow and Petrovic, 1992). Wear injury involves direct damage to shoot tissues (e.g. by mechanical pressure, abrasion, scuffing, tearing, or divoting) and dominates the effects of traffic stress on high-sand root zones and when moisture becomes limiting on heavy soils, while soil compaction dominates on fine-textured soils at high moisture contents, particularly at or above field capacity (Roche *et al.*, 2009).

Sportsfields are commonly classified into four categories (i) elite (world-class), (ii) regional (which contain significant infrastructure), (iii) premier (A-grade clubs) and (iv) community based sportsfields. Generally speaking, elite and regional, as too some premier fields, are constructed using high-sand root zones, whereas (many) premier and community sportsfields are constructed using heavy soils. No matter what their construction they all aim to have the best quality turf.

In Australia, green couch (*Cynodon dactylon*) and *Cynodon* hybrid (*C. dactylon* x *transvaalensis*) form the basis of the playing surface on most modern sports venues and higher level sportsfields. However, many premier and community sportsfields are still widely using kikuyu (*Pennisetum clandestinum*) and in Queensland, blue couch (*Digitaria didactyla*). In states like Victoria and New South Wales, kikuyu is commonly utilised because of its cold tolerance compared to green or hybrid couch which often goes dormant in winter. Ryegrass (*Lolium* sp.) is also used at venues that wish to over-sow their playing surfaces.

Morphological characteristics, growth habit and adaptation of species and varieties vary considerably. For example, some cultivars grow faster than others at different times of the year; some are more strongly winter dormant and slower to recover in spring than others; some produce stronger underground mats of rhizomes and tighter above-ground mats of stolons; some produce higher shoot density and are more prone to developing thatch; some are more fertility-demanding in terms of available soil nitrogen; and the optimum pH range also appears to vary for different cultivars (Roche *et al.*, 2009). Such variation might be related to differences in wear tolerance as suggested by Roche *et al.* (2009).

Within the earlier Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ) wear studies (Roche *et al.*, 2009) little focus was provided towards soil compaction and relief, particularly within the simulated Redlands Research Facility (RRF) wear facility. However, soil compaction (i.e. the pressing together of soil particles and destruction of aggregates by traffic resulting in a denser soil mass with reduced macropores, increased bulk density, and greater soil strength) (Carrow and Petrovic, 1992) is of particular concern with community based sportsfields because of their construction method and materials used (available). For example, excessively fine-textured (i.e. high in clay and silt content) soil profiles commonly seen on community fields are prone to compaction due to reduced oxygen diffusion and minimal pore space. Deterioration occurs through both man-made (e.g. intensive use) and natural causes (e.g. an accumulation of thatch arising from under-use) with large differences being found between high and low wear areas (Henderson *et al.*, 2007).

In an effort to measure and reduce soil compaction, amendments and physical treatments tested by researchers have provided mixed results. As seen in Henderson *et al.* (2007), neither a Verti-Drain nor a deep aerating rotovator produced a long-term loosening effect, or any change in puddle formation, or playability on sporting fields, in the Netherlands (Zwiers, 1987). Similarly, a range of cultivation treatments failed to improve oxygen diffusion into soil profiles assessed on golf courses in the USA (Carrow 1990) and failed to have any long-term effects on the density or colour of the turf in the United Kingdom as measured by reflectance ratio (Baker *et al.*, 1999). In Australia, aeration using Verti-Drain reduced surface hardness and soil strength and improved infiltration rate and volumetric soil moisture in a clay loam profile. However, the effectiveness was short term, and much reduced with active play (Aldous, James *et al.* 2001). Similar results were seen in studies by Henderson *et al.* (2007), upon their investigation of surface hardness and player safety. They recommended regular amelioration activities using decompaction methods (e.g. aeration) to reduce compaction and hardness.

Sports turf managers are constantly working to achieve a uniform, aesthetic and safe playing surface. A significant component in achieving this is through mowing. Warm-season turfgrasses rarely see winter dormancy as they are predominantly grown in sub-tropical and tropical environments. Consistent vegetative growth (e.g. rhizomes and/or stolons) can be desirable following heavy traffic; however leaf or canopy growth can be a burden on resources. In an effort to reduce mowing practices and increase turf quality; sport turf managers, greenkeepers and superintendents have used plant growth regulators (e.g. active constituent trinexapac-ethyl). Commonly known as PGRs, the pesticide is used to regulate (inhibit or decrease) leaf and stem growth of the turf plant. However, given that PGR's are pesticides and often contain synthetic chemicals, the potential for phytotoxicity damage (leaf burn to death of the turf plant) to occur warrants cautious usage. Turf managers must make sure that their species and or cultivar is listed on the product label and that due diligence is observed when applying even recommended rates of the pesticide.

Turfgrass selection, decompaction and PGRs are three components investigated within the present study following trials being established at three different locations including RRF, Redlands Touch Association (RTA) and The University of Queensland (UQ). The RRF site hosted the simulated wear study investigating traffic tolerance, and PGR trials to assess the phytotoxic response of (lawn bowls and golf) greens-quality grasses and mowing frequency studies of medium- to coarse-textured grasses suitable for sportsfield use. The RTA site comprised two separate actual wear (through the playing of touch football games) studies and provided researchers with an opportunity to compare replicated data of both simulated versus actual wear. The final element was that of a case study conducted at UQ to compare promising wear tolerant grasses versus the industry standard green couch cultivar 'Wintergreen'. This provided DAFFQ research staff with the opportunity to see how the results from relatively small scale plots (e.g. < 40 m²) compared with plots 1,500 m² in size, with each plot covering one-quarter of a football field.

Each trial site has its own chapter and for the two Redlands studies, RRF and RTA, each chapter is further broken into sub sections containing relevant studies as identified above.

2. Redlands Research Facility (RRF)

RRF Simulated Wear Study

Introduction

Since 2006, turf research staff at the Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ) Redlands Research Facility (RRF) wear tolerance studies have been undertaken on a range of turfgrasses suited for home/recreational use (e.g. *Stenotaphrum secundatum* – buffalograss) under both elite and community sportsfield conditions. The work has been undertaken using Redlands Wear Traffic Simulator, which is based on the design of the University of Georgia's GA-SCW Simulator (Carrow *et al.*, 2001). The ride-on self-propelled machine enables traffic (wear and compaction) treatments to be applied rapidly and uniformly across a trial.

DAFFQ studies undertaken between 2006 and 2008 of 8 *Cynodon* spp. cultivars trialled for elite conditions showed that wear tolerance was associated with high shoot density, a dense stolon mat strongly rooted to the ground surface, high cell wall strength as indicated by high total cell wall content, and high levels of lignin and neutral detergent fiber (NDF) (Roche *et al.*, 2009); not shoot moisture content as suggested by Trenholm *et al.* (1999, 2000) and Brosnan *et al.* (2005) for other species. Wear tolerance was also affected by turf age, planting sod quality, and wet weather.

Within the earlier DAFFQ wear studies little focus was given to assess soil compaction and relief, particularly within the Redlands simulated wear facility. Australian studies (e.g. Aldous *et al.*, 2001 and Henderson *et al.*, 2007) concluded that effectiveness of decompaction work was only short lived. If any (long-term) benefit was to be made by conducing amelioration activities, regular physical treatment was required, not annual works which is seen by a number of councils and community sportsfields. Research by Henderson *et al.*, (2007) also identified that having 15-30 % percent soil moisture was ideal to reduce surface hardness and maintain a Gmax ("tens of gravities) reading between 70-80 Gmax of community sportsfields.

In the present study, 4 simulated wear trials were run at RRF between 2009 and 2012 to asses traffic stress (wear and compaction) across 8 warm-season turf varieties containing green couch (*Cynodon dactylon*), *Cynodon* hybrid (*C. dactylon* x *C. transvaalensis*), blue couch (*Digitaria didactyla*) and kikuyu (*Pennisetum clandestinum*). The aim was to document the effects of (simulated) traffic stress to identify which varieties would provide more suitable in meeting user requirements, and how effective a periodic decompaction program was compared with more regular scheduling.

The information collected is to assist turf managers care for their sportsfield whether it is at an elite, regional, premier or community sports level. But with this information, turf managers need also be provided with appropriate levels of training and resources to provide safe and playable sportsfield for everyone to enjoy.

Material and Methods

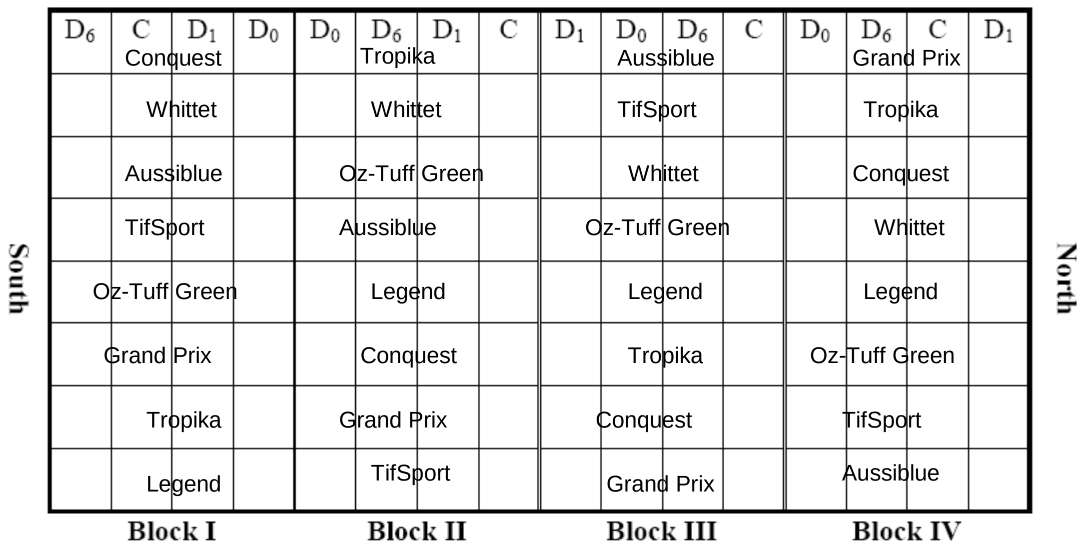
The experimental site was located at Redlands Research Facility (RRF) (27º32'S lat, 153º15'E long, 50 masl), Cleveland, Queensland, Australia on a 15-cm deep sand (fine bedding sane from River Sands) profile with pop-up irrigation and internal drainage to remove excess water. The experimental area was situated on a level area receiving full sunlight throughout the day.

The basic experiment was a randomised block design, with 4 replications of 8 warm-season cultivars in individual plots measuring 6 x 2 m. The turfgrasses included in the experiment were the *Cynodon dactylon* (green couch) cultivars ‘C1’ (marketed as Legend®), ‘Grand Prix’, OZ TUFF™ and ‘Riley’s Evergreen’ (marketed as Conquest™); the *C. dactylon* x *C. transvaalensis* (*Cynodon* hybrid) cultivar ‘Tift 94’ (marketed as TifSport™); the *Digitaria didactyla* (blue couch) cultivars ‘Aussiblue’ and ‘Tropika’; and the single *Pennisetum clandestinum* (kikuyu grass) cultivar ‘Whittet’. Subsequent references to these cultivars in the report are made under the names by which they are sold commercially.

Superimposed over the basic randomised block experiment was a strip-plot design to accommodate 4 wear treatments (combination of wear and decompaction). Wear treatments were C (control, no wear, no decompaction), D0 (wear applied weekly, no decompaction), D1 (wear applied weekly, decompaction ≈ once per year) and D6 (wear applied weekly, decompaction ≈ at six-week intervals). Each subplot measures 1.5 x 2 m.

The D1 and D6 decompaction treatments were applied 3 and 13 times respectively throughout the duration of the study. They were D1: 15 Jun 2009, 17 Jun 2010 and 15 Jul 2011; and D6: 15 Jun, 31 Aug, 20 Oct, 21 Dec 2009, 11 Mar, 17 Jun, 5 Aug, 7 Oct, 3 Dec 2010, 30 May, 15 Jul, 21 Oct 2011 and 22 Feb 2012. Decompaction was undertaken with a Verti-Drain machine using 20 mm solid tynes to a depth of 150 mm with (usually a) 3 % kick. Inclement weather and the availability of the decompaction machine often stretched the dates between applications.

Figure 1. RRF wear trial plan showing the setup of the turf varieties (plots running south to north) and the overlay of wear and decompaction (D0, D1, D6) treatments (applied east to west). Refer to Plate 4 to see digital images of the plot layout.



All 8 cultivars were laid as (unwashed) sod between 8 and 12 Jan 2009. Further sod installations of Whittet took place on 22 Jan 2010 and 21 Sep 2011 because of traffic damage and poor recovery following wear applications. All sod following planting was rolled, mown and topdressed to facilitate their establishment before starting the first wear trial (Year 1) just 4 months later. Four series of wear trials were conducted throughout the duration of the study which is grouped as follows: Year 1 – 13 May 2009 to 6 Apr 2010; Year 2 – 7 Apr 2010 to 3 Feb 2011; Year 3 – 4 Feb 2011 to 6 Feb 2012; and Year 4 – 7 Feb to 1 May 2012. The fourth year wear study only ran for a short duration because of the project end date being 31 May 2012.

Wear was applied using the Redlands Wear Traffic Simulator (Plate 1) which is a modified Brinkman design based on the self-propelled GA-SCW Traffic Simulator (Carrow *et al.*, 2001). The major difference between the GA-SCW Traffic Simulator and the self-propelled Redlands Traffic Simulator was the latter used smooth rubber galvanised rollers (1m wide) to cause scuffing of the turf surface rather than studded rollers rotating at different speeds. Except for the first 8 wear occasions in Year 1 where 20 passes of the Redlands Traffic Simulator was used, 10 passes was adopted for the duration of the study.

Plate 1. Redlands Wear Traffic Simulator in operation across the simulated wear site at Redlands Research Facility. Plots run from the front to the rear of the photo, whereas the treatments (wear and decompaction) run from left to right or vice-versa in the same direction of travel as the wear machine pictured.

Table 1. Details of wear trial management between during 2009 and 2012 of the simulated wear study at Redlands Research Facility.

Wear trial year	Wear application periods		Duration (d)	No. of fertiliser applications	Nutrients applied (kg ha^{-1})			No. of wear events
	Start	Finish			N	P	K	
1	13 May 2009	9 Dec 2009	211	3	244	23	71	8[†] 12
2	7 Apr 2010	25 Nov 2010	233	5	250	21	94	25
3	4 Feb 2011	30 Nov 2011	300	3	205	52	52	29
4	7 Feb 2012	1 May 2012	85	1	39	0	31	11
Total	-	-	*829*	*12*	*738*	*96*	*248*	*85*

Note: [†] 20 passes of the wear machine was implemented 8 times between 13 May and 26 Aug 2009, but thereafter 10 passes was adopted.

Near the end of the study, 18 Jan 2012, leaf material (≈ 5g) were cut from each of the control (unworn and not decompacted) subplots to determine moisture content and the levels of fiber, lignin and ash using standard forage analytical techniques (e.g. Coleman et al, 2004) and adapted methodologies to determine Lignin, Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) Total Cell Wall content (TCW) as per Roche *et al.* (2009). Forage analytical testing was conducted by The University of Queensland and findings provided to DAFFQ research staff for analysis and interpretation.

Visual assessments of turf quality [1 (= worst) to 9 (= best); 6 = acceptable] and the percentage of bare ground in the worn sub-plots were made generally fortnightly by 1, 2 or 3 independent assessors to follow the effects of the different wear and decompaction treatments (D0, D1, D6). Rankings of wear tolerance were made based on mean wear data collected in separate studies (Table 2), but also collectively (group average) over the four years (Table 3).

Traction testing was conducted on 24 occasions throughout the study. On all but 1 occasion, the Redlands Automated Traction Tester (as detailed in Roche *et al.*, 2007 and herein referred to as the Redlands Traction Tester) was used. For testing on 27 May 2011 the manual Studded Boot Apparatus (Canaway and Bell, 1986) (Turf Tec Australia Manual Traction Tester) was used. Percentage moisture using a Field Scout® TDR 300 Soil Moisture Probe (Spectrum Technologies, Inc., USA) was used to take three readings per subplot. Surface hardness was assessed using a 2.25 kg Medium Clegg Impact Soil Tester (Dr Baden Clegg, WA) (1^{st} and 4^{th} drops from a height of 303 mm and 457 mm were taken; however, primarily the 4^{th} drop at 457 mm will be discussed within this report) almost monthly of each subplot throughout the duration of study. Turf colour was also assessed using the Field Scout® Turf Colour Meter 500 (Spectrum Technologies Inc., USA). A single measurement per subplot was collected each day of testing (data not included in this report).

The whole experimental area was well-fertilised (as summarised in Table 1), irrigated routinely to maintain "unstressed" growth and mown regularly (to 25 mm) to simulate sports field management conditions. Pre-emergence applications of Ronstar® G (oxadiazon) or Ronstar® + fertiliser 18:10:9 was also utilised periodically throughout the duration of the study. Non-selective herbicides (glufosinate ammonium) registered as Finale® and Basta® was applied to plot borders to prevent encroachment between cultivars. Root Barrier® was also installed to a depth of 100 mm between cultivars to limit rhizome movement between plots. Soil samples were taken annually and sent to the AGCSATech laboratory for comprehensive soil testing.

All data were analysed through GenStat® Release 14.2 for PC (Windows/XP) using standard Analysis of Variance procedures, which also generated Fisher's protected Least Significant Differences (LSDs) for comparison of treatment means. Graphs were constructed using SigmaPlot® Version 11.1 and Microsoft® Office Excel 2003.

Results

Turf quality was generally at or above acceptable (6 = acceptable) of the control plots throughout the duration of the study (Table 2). However, once traffic was applied to the turf wearable plots (DO, D1 and D6) using the Redlands Traffic Simulator noticeable damage was soon observed to shoot tissues through mechanical pressure, abrasion, scuffing and or tearing. After 8 weeks at 20 passes of Redlands Traffic Simulator, it was observed that turf quality of the worn plots had dropped significantly and it was decided to reduce the number of wear passes from 20 to 10. The reduction was also required initially to attempt to simulate wear damage seen at the Redlands Touch Association fields too (refer to chapter 3).

Turf quality was highest in the green couch varieties (herein includes the *Cynodon* hybrid variety) throughout the duration of the study (e.g. Plate 2). The least impressive were the blue couch varieties and more so, the single kikuyu variety. The difference in quality was a direct result of wear and tear encountered by the turf and its ability to withstand and recover from traffic. The lowest turf quality readings were seen at the end of each wear application period of each year (Table 2); prior to the recovery process. The stand out cultivars at this point in time was once again the blue couch and kikuyu varieties which rated as low as 1.2 and 0.9 in turf quality. At this point in time little to no turf, only straw like material (minimal to no leaf matter) remained.

Table 2. Mean annual turf quality ratings of control (no wear or decompaction) and worn plots (D0, D1 and D6) for the 8 cultivars trialled within Year's 1, 2, 3 and 4. A mean turf quality rating of the worn plots is also shown. The latter (final rating) data is from when the wear application period finished within each trial year (refer to Table 1).

	Year 1			Year 2		
Cultivar	**Control Plot** (mean annual value)	**Worn Plots** (mean annual value)	**Worn Plots** (final rating*)	**Control Plot** (no wear or decompact.)	**Worn Plots** (D0,D1,D6)	**Worn Plots** (final rating*)
Aussiblue	7.5	3.5	1.4	7.5	2.7	3.0
Conquest	6.1	4.4	4.3	6.0	3.8	4.1
Grand Prix	6.8	5.3	5.6	6.9	4.6	5.2
Legend	6.5	5.0	5.2	6.4	4.3	4.9
OZ TUFF	7.2	5.6	5.4	7.0	5.8	6.0
TifSport	7.0	5.3	4.8	6.5	4.0	4.3
Tropika	7.4	3.7	2.8	7.2	2.0	0.9
Whittet	5.8	3.6	1.2	5.4	1.9	1.7
	Year 3			**Year 4**		
Cultivar	**Control Plot** (no wear or decompact.)	**Worn Plots** (D0,D1,D6)	**Worn Plots** (final rating*)	**Control Plot** (no wear or decompact.)	**Worn Plots** (D0,D1,D6)	**Worn Plots** (final rating*)
Aussiblue	7.6	5.4	6.8	7.6	5.8	5.6
Conquest	6.7	5.2	5.7	6.6	5.4	4.9
Grand Prix	7.3	5.8	6.5	7.2	6.1	5.9
Legend	6.9	5.5	6.2	6.6	5.9	5.6
OZ TUFF	7.4	6.9	7.2	7.3	7.0	7.2
TifSport	6.6	5.1	6.1	6.4	5.5	4.9
Tropika	7.3	4.7	6.6	7.4	5.7	5.1
Whittet	6.0	3.1	5.9	6.5	3.2	1.4

Note: Of the worn plots (D0, D1, D6), only D1 and D6 underwent physical (decompaction treatments). LSD values are not shown. * final rating refers to the rating undertaken immediately after the last wear event for that particular year i.e. Year 1 – 9 Dec 2009, Year 2 – 25 Nov 2010, Year 3 – 30 Nov 2011 and 1 May 2012.

Plate 2. Variation in turf quality and percentage bare ground is clear between (left to right) green couch, blue couch and kikuyu species. Photos were taken 20 Oct 2009.

Wear patterns observed throughout the four-year study showed enormous variation in wear tolerance and recovery between the three species trialled (green couch, blue couch and kikuyu) (Plate 2, Table 3 and Figure 2). If recommendations by McAuliffe and Roche (2009) were followed, that is if a field comprises ≥15 % wear it should be considered unfit for play, the wear observed within the RRF study would have meant that closures hypothetically would have resulted. For example, if a sportsfield undergoes high usage (as simulated at the RRF trial site) and was planted with blue couch (e.g. Aussiblue, Tropika) the field would be out of play between 25-80 % of the time. If sufficient recovery time and sound turf management practices are available, complete recovery (100 % cover) is possible because of Aussiblue and Tropika's rapid stoloniferous growth produced when growing conditions are optimal (Plate 3).

Plate 3. *Digitaria didactyla* cv. Aussiblue recovery of treatment D6 (simulated wear plus decompaction at six-week intervals) at Redlands Research Facility (left to right: 9 Nov 2009, 3 Feb and 5 Mar 2010).

Following the same recommendations, if kikuyu (e.g. Whittet) was planted on a high usage sportsfield that had scheduled bookings and or illegal play, the field could be closed between 64-100 % of the season. Within the present study, insufficient stoloniferous recovery occurred and twice the kikuyu plots had to be re-established by DAFFQ staff in Jan 2010 and Nov 2011. Even after new turf was planted, the onset of decline soon followed having to undergo traffic often several weeks post planting (e.g. Figure 2a and 2c).

If a variety of green couch were planted (e.g. Conquest, Grand Prix, Legend, OZ TUFF, TifSport) there is a greater chance of not having to cancel team training runs or official fixtures because of the field being deemed unfit for play. This however would be largely dependent on varietal selection. On average, green couch cultivars produced ≥15 % wear between 0-65 % of the time. This was the lowest percentage of time for all three species of turf. However, significant variation was present within the green couch varieties with wear damage being between 2 % and 90 %.

Wear ranking remained very consistent over the four years, but to a lesser extent in its final year due to only a limited number of wear applications (11) being imposed. This mean that cultivar variation was less pronounced compared with earlier years that saw 20, 25 and 29 wear events applied respectively. Within the first three years, OZ TUFF was ranked number one, whereas in the fourth year, it was comparable to Grand Prix and Legend. The latter two varieties ranked equal second in the first three years, whereas TifSport ranked the same only within the first two years and not the third. During the third year, TifSport and Conquest ranked equal forth. Conquest showed the least wear tolerance out of all the *Cynodon*'s trialled at the RRF facility.

Table 3. The amount of wear (bare ground) observed following analysis of collected data from within the RRF simulated wear study during (a) Year 1 – 13 May 2009 to 6 Apr 2010 and Year 2 – 7 Apr 2010 to 3 Feb 2011; and (b) Year 3 – 4 Feb 2011 to 6 Feb 2012 and Year 4 – 7 Feb to 1 May 2012. With the exception of wear tolerance, data are expressed as percentages.

(a)

	Year 1			
Cultivar	**Time when wear is ≥ 15%**	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Aussiblue	77	52	93	8
Conquest	61	26	65	5
Grand Prix	12	8	33	2
Legend	30	12	44	2
OZ TUFF	0	2	8	1
TifSport	8	8	30	2
Tropika	76	45	90	6
Whittet	76	41	93	6
LSD (P=0.05)	-	*5*	-	-
	Year 2			
Cultivar	**Time when wear is ≥ 15%**	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Aussiblue	80	56	97	6
Conquest	65	32	90	5
Grand Prix	55	21	71	2
Legend	64	25	70	2
OZ TUFF	0	4	14	1
TifSport	65	28	89	2
Tropika	80	68	99	7
Whittet	100	69	88	7
LSD (P=0.05)	-	*5*	-	-

Note: Assessments totalled 66 in Year 1 and 55 in Year 2. Turf replacement of all Whittet plots occurred on 22 Jan 2010; therefore rankings and values of this cultivar are slightly skewed in Year 1. Wear ranking is based on mean bare ground data collected for each year; * 1=best, 8=worst.

(b)

Cultivar	Year 3			
	Time when wear is ≥ 15%	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Aussiblue	41	23	88	4
Conquest	48	21	70	4
Grand Prix	36	14	57	2
Legend	41	16	41	2
OZ TUFF	0	2	9	1
TifSport	45	25	81	4
Tropika	68	33	91	7
Whittet	64	57	98	8
LSD (P=0.05)	-	*6*	-	-
Cultivar	**Year 4**			
	Time when wear is ≥ 15%	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Aussiblue	25	10	30	4
Conquest	42	15	42	4
Grand Prix	8	7	24	1
Legend	8	8	18	1
OZ TUFF	0	0	2	1
TifSport	42	14	42	4
Tropika	33	13	49	4
Whittet	75	57	89	8
LSD (P=0.05)	-	*9*	-	-

Note: Assessments totalled 44 in Year 3 and 12 in Year 4. Turf replacement of all Whittet plots occurred on 21 Sep 2011; therefore rankings and values of this cultivar within Year 3 are slightly skewed. Wear ranking is based on mean bare ground data collected for each year; * 1=best, 8=worst.

Following forage analytical testing across 8 *Cynodon* spp. cultivars by Roche *et al.* (2009), chemical analysis was also carried out across the 8 varieties being trialled within the present RRF simulated wear study. Contradictory to findings in the previous study, lignin, neutral detergent fiber and total cell wall content values did not correlate to the cumulative wear tolerance ranking (Table 4), or with the Year 4 wear tolerance ranking (Table 3) in the same year samples were collected from the trial.

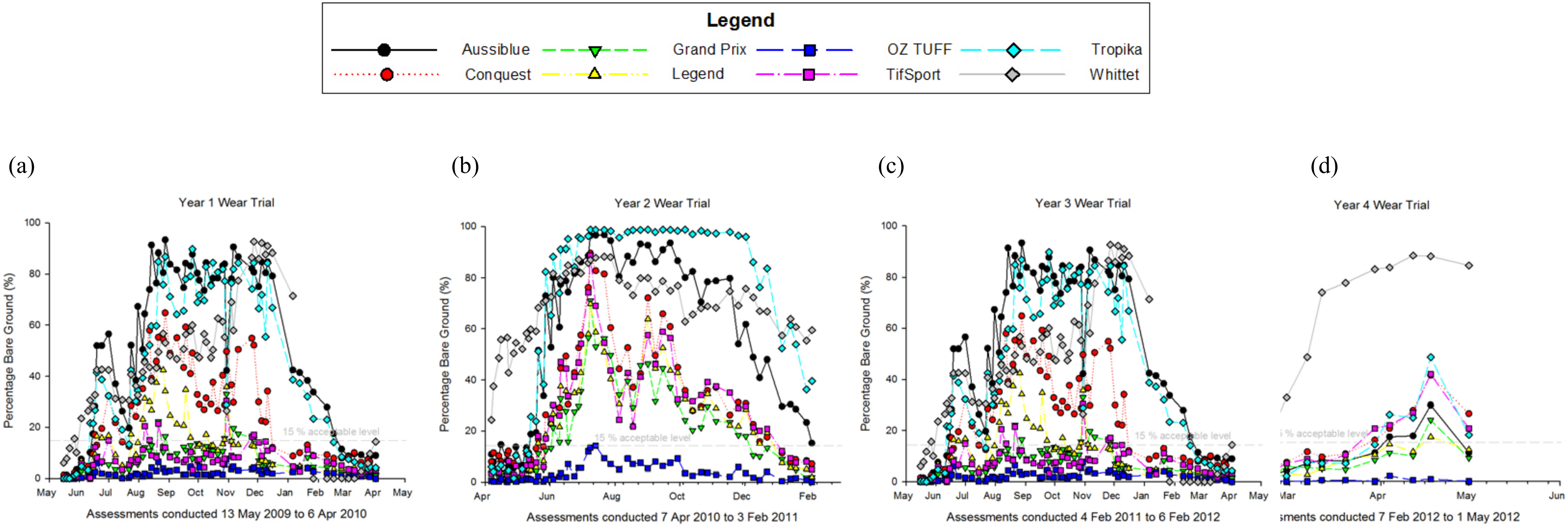
Table 4. Moisture content and chemical analysis of structural components in samples of leaf material taken from 8 warm-season turf varieties growing in the RRF wear facility on 18 Jan 2012. All chemical analysis data are expressed as percentages.

Cultivar	**Wear tolerance ranking***	**% moisture in fresh samples**	**Ash (%)**	**ADF (%)**	**Lignin (%)**	**NDF (%)**	**TCW (%)**
Aussiblue	6	43.2	8.1	28.7	3.4	71.6	42.9
Conquest	5	53.3	9.0	33.9	4.1	81.9	47.9
Grand Prix	2	56.2	9.0	33.2	4.0	80.9	47.7
Legend	2	53.0	8.2	32.6	3.9	79.7	47.1
OZ TUFF	1	50.8	8.4	34.3	4.1	81.2	46.9
TifSport	2	57.2	8.5	32.8	3.9	81.0	48.3
Tropika	6	45.4	8.1	30.8	3.7	73.6	42.8
Whittet	8	47.3	8.3	31.9	3.8	76.7	44.8
LSD (P=0.05)	-	*9.8*	*0.4*	*1.9*	*0.2*	*2.7*	*1.9*

* 1=best, 8=worst; wear tolerance ranking is based on the mean ranking over four years (ranking data from Table 3).

Plate 4. Aerial photographs of the RRF simulated wear facility taken (a) 16 Apr 2009 (facing south), (b) 24 Jun 2009 (facing west), (c) 4 Jun 2010 (facing north), and (d) 22 Mar 2012 (facing south).

Figure 2. Mean combined (D0, D1, D6) percentage bare ground ratings undertaken of the RRF simulated wear trial during (a) Year 1, (b) Year 2, (c) Year 3 and (d) Year 4.



Note: Turf replacement of all Whittet plots occurred on 22 Jan 2010 (Year 1) and on 21 Sep 2011 (Year 3).

Figure 3. (a) Decompaction treatments being imposed to D1 and D6 plots on 15 Jun 2009 at RRF by Terry Griffiths of Q Turf Machinery; (b) Verti-Drain decompaction unit using 20 mm solid tynes; and (c) impact of decompaction treatment on worn plots showing 150 mm spacings.

(a)

(b)

(c)

Decompaction treatments were undertaken at the RRF simulated wear trial site on 3 and 13 occasions for the D1 (yearly) and D6 (≈ six week intervals) treatments respectively. The purpose of the amelioration program at diverse intervals was to simulate what a community sportsfield may encounter if a standard turf management (decompaction) program is in place (D1), verses an improved program (D6).

(De-)Compaction was assessed at routine intervals throughout the 4 year study to coincide with treatment work and other data collection e.g. percentage soil moisture. Of the control plots, which had no traffic stress (compaction or wear form the Redlands Traffic Simulator), the minimum and maximum 4th drop G_{max} from a drop height of 457 mm over the course of the study was 58 and 98 G_{max} (Figure 4). Soil moisture at the time of these observations were +0.7 % and -4.8 % off the mean percentage moisture value of 21.8 % which is within the recommended range of 15-30 % recommended by Henderson et al. (2007).

Hardness for worn plots (D0, D1, D6) showed that routine decompaction practices were beneficial in relieving surface hardness. The D0 treatment (wear only, no decompaction) revealed a mean G_{max} of 103, whereas the mean D1 and D6 treatment values were 105 and 96. These findings coincide with the recommendations provided by Henderson et al. (2007) in that infrequent amelioration techniques will only provide short-term gain.

The peaks and troughs of the recorded G_{max} values, on the most part, ignoring the decompaction work, tracked largely with seasonal changes and climatic conditions (rainfall).

Figure 4. Surface hardness (Gmax of 70-80 is ideal, ≥ 120 is concerning) of turf treatments (C, D0, D1 and D6) at Redlands Research Facility between May 2009 and May 2012. The control (C) treatment is included; however it should not be compared with the de-compaction treatments (D0, D1 and D6) because it is not undergoing simulated wear (compaction of the Redlands Traffic Simulator). Gmax values shown are of the 4th drop from a 457 mm height. LSD values are not shown.

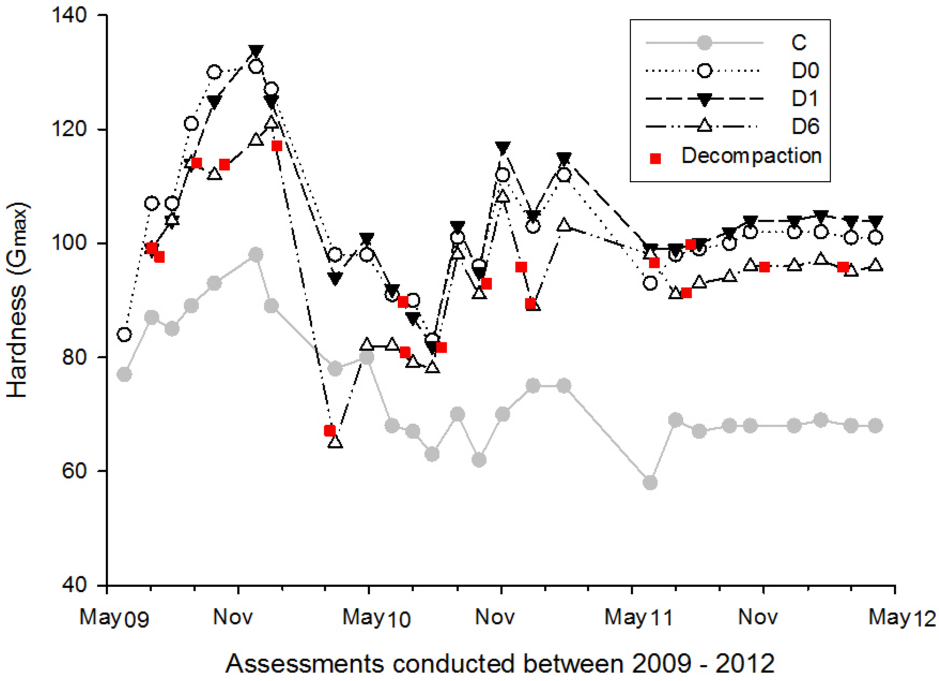
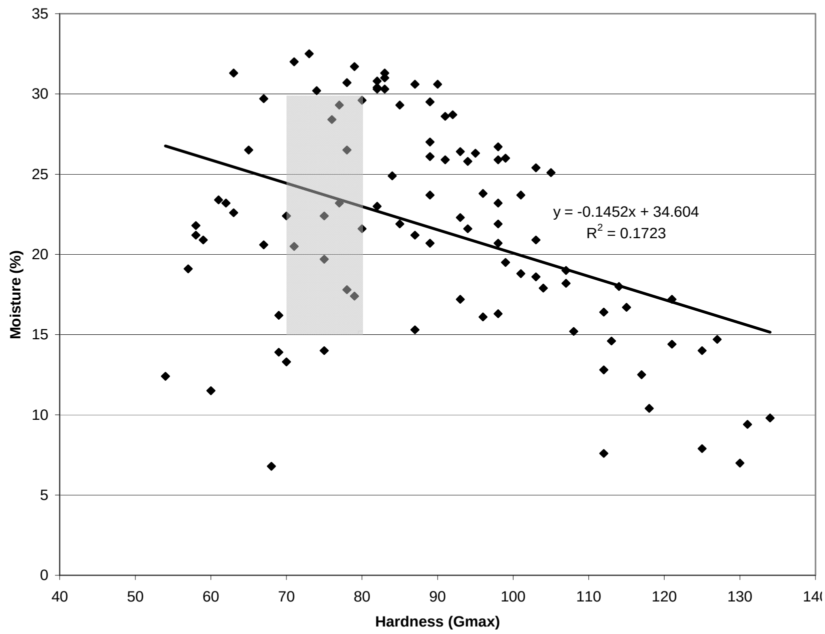


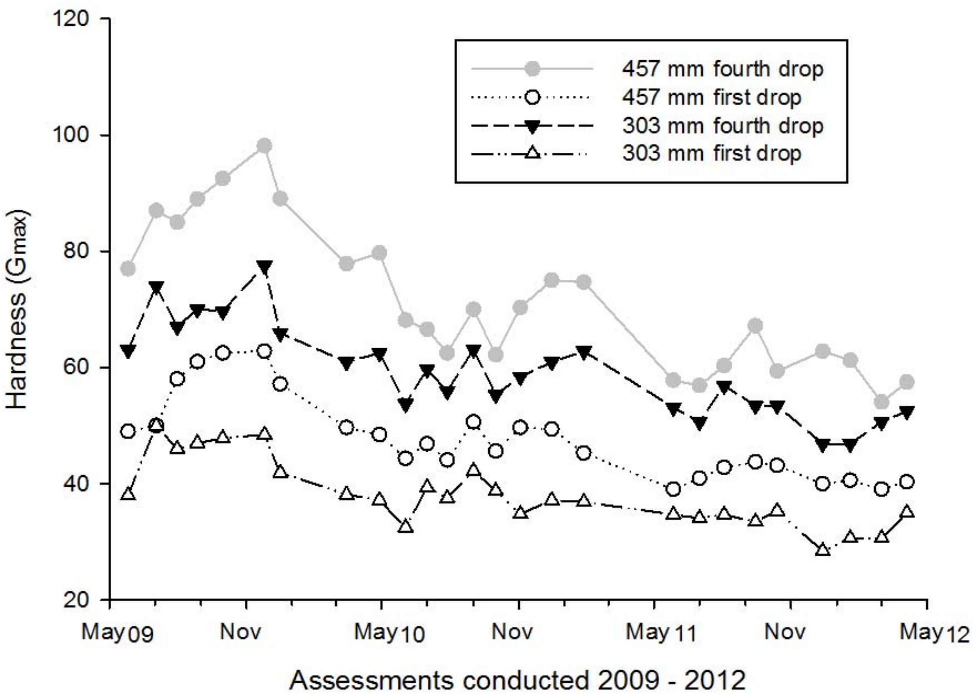
Figure 5. Correlation between soil moisture (%) and surface hardness (4th drop Gmax) from the mean data collected within the C, D0, D1 & D6 plots of the RRF simulated wear study between 26 May 2009 and 26 May 2011. The recommended range is highlighted in grey.



A moderate negative correlation (r = -0.42 or R^2 = 0.17) was observed between surface hardness (G_{max}) and percentage soil moisture within the (fine bedding) sand profile (Figure 5). Generally speaking this means the higher the percentage soil moisture, the softer the ground.

Throughout the course of the RRF simulated wear study four different Clegg impact hammer readings were acquired, being the 1st and 4th drop of the hammer from a height of 303 mm and 457 mm. The data set was collected due to the large variation present within the turf industry when it comes to how to measure surface hardness. Values collected were from the control (unworn or decompacted) plots of each variety and grouped to show a collective mean across each day of testing (Figure 6). To a large extent the figures mirror each Clegg hammer treatment or test method as shown across the 25 test dates between 2009 and 2012.

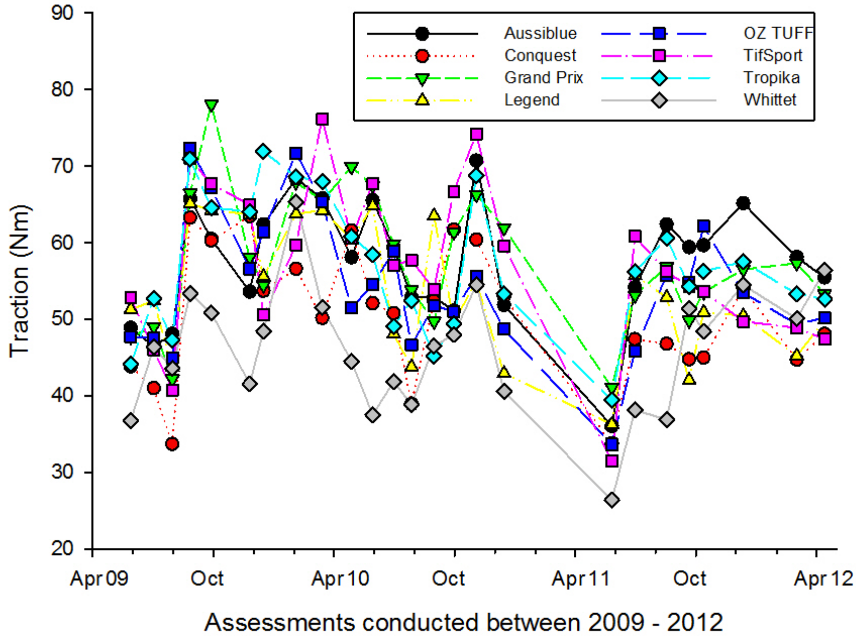
Figure 6. Comparison of 1st and 4th drops from a height of 303 mm and 457 mm from within the control plots of the Redlands simulated wear study site between 2009 and 2012. G_{max} values are shown. LSD values are not shown.



A secondary variable assessed from within the RRF turf plots (all plots/treatments – however, only control data is shown within this report) was traction. Australia's elite sports bodies (e.g. Australian Football League (AFL), Australian Rugby Union (ARU)) consider traction and surface stability as the two most important factors in the playability and performance of a sports turf surface (McAuliffe and Roche, 2011).

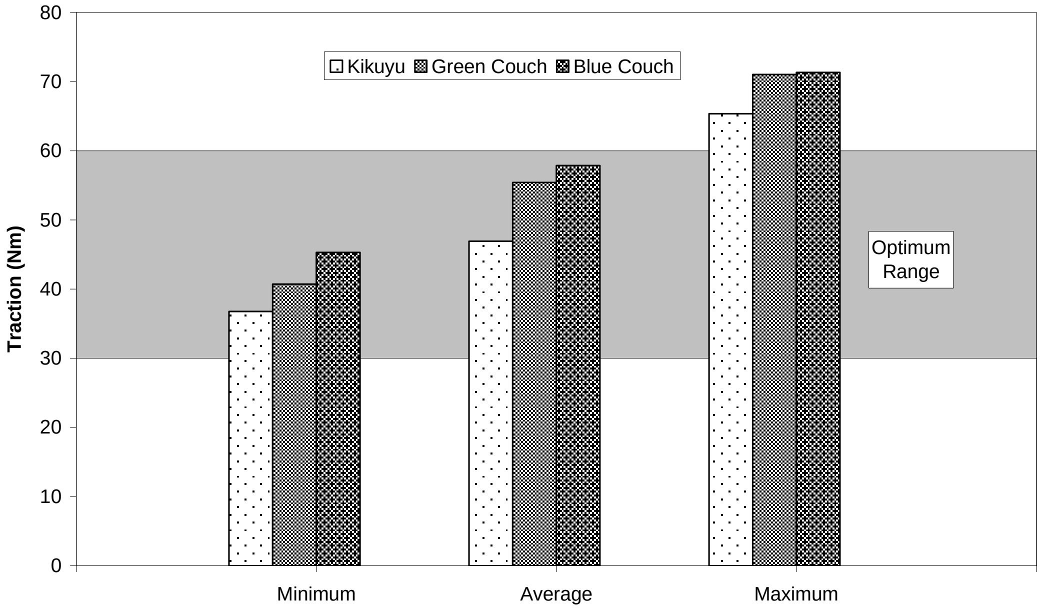
Traction (Nm) values varied significantly from within the control plots over the four year period which ranged from 34-78 Nm (Figure 7). Grouping by species proved interesting (Figure 8). On average the blue couch species showed to have a higher level of traction than the kikuyu or green couch varieties. However, varietal differences within species showed the green couch cv. Grand Prix as having the highest level of traction at 78 Nm, whereas Conquest within the same species only reached 63 Nm.

Figure 7. Traction (Nm) values of the control (no wear or decompaction) plots within the RRF simulated wear study using the Redlands Traction Tester*. On 25 occasions traction data was collected between 13 May 2009 and 1 May 2012.



* On the 27 May 2011 the manual Studded Boot Apparatus was used. The manual tester provided lower traction (Nm) figures compared with the automated tester and was discarded from analysis.

Figure 8. Mean traction (Nm) values collected of the blue couch (cv. Aussiblue, Tropika), kikuyu (cv. Whittet) and green couch (cv. Conquest, Grand Prix, Legend, OZ TUFF, Wintergreen and TifSport) control plots over the 25 testing dates between 13 May 2009 and 1 May 2012.



Discussion

This was the first time wear testing of this kind had been undertaken across such a diverse number of warm-season turfgrass species suited for recreational use and sportsfields. The wear tolerance and recovery figures collected provides distinct variation between turf species and highlights the need for serious consideration before user groups can decide on a grass variety before thinking of their (usage) requirements and user expectations.

Green couch varieties withstood the effect of traffic (wear and compaction) appreciably better than blue couch varieties and the single kikuyu variety. In a worst case scenario, if a field was to experience high usage as seen within the present study, and decided to plant either green couch, blue couch or kikuyu, the sporting club could pose to risk potential field closure for up to 65% (green couch), 80 % (blue couch) or 100% (kikuyu) of the season depending on their choice. Not to mention the need for turf replacement that may be needed. The kikuyu plots within the RRF wear trial were replaced on two occasions, in Year 1 and Year 3 of the four year study. In order to maintain suitable cover this number could have been much higher.

Wear tolerance rankings remained very much consistent throughout the course of the study. Only when wear levels were lower, as per Year 4 of the RRF study, are cultivars more comparable then under high or intense wear. This is a good thing particularly if usage requirements are low and wear patterns or high traffic areas (e.g. goal squares) are restricted to allow turf recovery.

Forage analysis/fiber testing results did not provide similar results to that of earlier work conducted by Roche *et al.* (2009) on *Cynodon* spp. for elite sportsfields. In the latter studies, researchers collected above ground vegetative material consisting of leaf and thatch for analysis. However, in the present study only leaf material was collected. It is possible that the lignin and Total Cell Wall content (TCW) concentration within the thatch layer is of greater importance than just the leaf material. This seems logical given that leaf material is often first to be removed from the turf plant through direct damage to shoot tissues (e.g. by mechanical pressure, abrasion, scuffing, tearing), leaving the thatch or stalks in place until complete loss (bare ground) is encountered. Further testing is warranted in this area to determine if this hypothesis is correct.

The mean percentage soil moisture observed during the RRF simulated study was 21.8 %. The latter value resulted in a moderate correlation ($r = -0.42$ or $R^2 = 0.17$) with surface hardness. The mean percentage moisture value is in the recommended range provided by Henderson *et al.* (2007). However, the soil type commonly seen in the latter studies (sandy loam to clay loam soils) is remarkably different to the fine bedding sand used within the RRF study. Therefore moisture levels required may need to be higher (e.g. nearer to 30 %) to provide hardness values between 70 and 80 G_{max}.

However, even though only a moderate correlation between surface hardness and moisture was observed, the collected hardness data coincides with the recommendations provided by Henderson *et al.* (2007) in that infrequent amelioration techniques will only provide short-term gain. Should sports turf managers and or clubs wish to achieve maximum benefit in compaction relief, rooting depth, water infiltration etc. more frequent decompaction work needs to be programmed into maintenance schedules.

Clegg hammer (G_{max}) values will be further analysed at a later date to determine if a formulae can be identified to determine a valid comparison ratio between different operating procedures when using the Clegg hammer.

Traction levels within the blue couch species were interestingly higher than expected. This was surprising given that blue couch species of turf do not have underground rhizomes, they are a stoloniferous grass. Rhizomes which are present in green couch species provide resistance and high traction levels as reported by Roche *et al.* (2007).

RRF trinexapac-ethyl and/or mowing studies

Introduction

As part of the TU08018 extension project DAFFQ staff following discussions with turf industry members wanted to trial trinexapac-ethyl (active constituent 120g/L) treatments across a range of medium- to coarse-textured warm-season turfgrass varieties to determine seasonal mowing requirements.

Trinexapac-ethyl is a plant growth regulator (pesticide) used by turf managers for growth regulation of leaf and stem growth of turfgrass, winter grass (*Poa annua*) management, vegetative suppression and reduction of seedheads within Bahia Grass (*Paspalum notatum*) and for couch overseeding. Trinexapac-ethyl's patent expired in 2007 and at the time of publication there were currently 5 products that contain this active ingredient registered with the Australian Pesticides and Veterinary Medical Authority (APVMA) for use on turfgrass. All 5 of the registered products contain limited information on the efficacy for a number of turfgrass species and varieties.

Phytotoxic damage, either minimal to severe (i.e. death of the plant), is of concern whilst using trinexapac-ethyl products because of limited species and varietal information on registered labels. Using *Cynodon* as an example, this is problematic for the following reasons: (i) in studies undertaken by DAFFQ researchers (Roche *et al.*, 2006; Roche *et al.*, 2010) phytotoxic data collected following selective pesticide applications to the *Cynodon* hybrid dwarf greens-quality grasses 'Tifgreen' and 'Tifdwarf' to varied significantly. Further collaborative works lead by Roche and Neylan (2010) saw golf course superintendents trial trinexapac-ethyl at recommended rates across a range of dwarf and "ultradwarf" varieties that resulted in the greens-quality grasses enduring leaf burn with a recovery period of 2-3 weeks; and (ii) trinexapac-ethyl was applied at a product rate of 1L/ha/month to *Cynodon* spp. plots undergoing wear and control plots (no wear) in studies conducted at RRF in 2007 by DAFFQ staff. Testing showed considerable variation among cultivars in their response to the rate of trinexapac-ethyl used (Loch and Roche, 2007). This had also been shown in earlier research conducted in the US (e.g. McCullough *et al.*, 2005). Numerous cultivars became extremely distorted and discoloured following the application of trinexapac-ethyl.

Another known benefit of using trinexapac-ethyl is to aid in turf management, in particular mowing reduction. Leading products containing trinexapac-ethyl suggests a 20 to 50 % reduction in clipping is achievable over a 2 to 6 week period at the recommended rate and under optimum management and environmental conditions. A reduction in mowing activities may seem insignificant to some; however, by following a reduced mowing program, it will not only save on resources, but also it will result in lower CO_2 emissions from turf machinery e.g. use of fuel to run mowers. Given the diversity in morphological-agronomic variation within warm-season turfgrasses used for home and recreational environments, it is unknown what benefit trinexapac-ethyl may in reducing mowing requirements.

The aim of the trinexapac-ethyl study was to determine what rate of trinexapac-ethyl had the ability to reduce mowing costs across a range of medium- to coarse-textured species and varieties of warm-season turfgrass commonly used across sports and recreational areas.

Trinexapac-ethyl use and mowing implications on medium- to coarse-textured varieties

Material and Methods

The experimental site was located at Redlands Research Facility Cleveland, Queensland, Australia on a red krasnozem clay profile. The experiment was a randomised block design, with 4 replications containing 19 varieties of medium- to coarse-textured turfgrasses. Of the 19, 10 varieties were green couch (*C. dactylon*) –, 'Grand Prix', 'OZ TUFF' (Oz-E-Green), 'CT-2', 'Wintergreen', 'Hatfield', 'Winter Gem', Conquest™ (Riley's Evergreen), 'Premier'[*], Legend® (C1) and 'Blue Dynasty'*; 4 varieties of *Cynodon* hybrid (*C. dactylon* x *C. transvaalensis*) – 'AGRD', TifSport™ (Tift 94) 'Santa Ana' and 'Patriot'*; 4 varieties of blue couch (*Digitaria didactyla*) – 'Tropika', 'Qld Blue Couch', 'Aussiblue' and 'MR-D1'*; and 1 cultivar of kikuyu (*Pennisetum clandestinum*) – 'Whittet'.

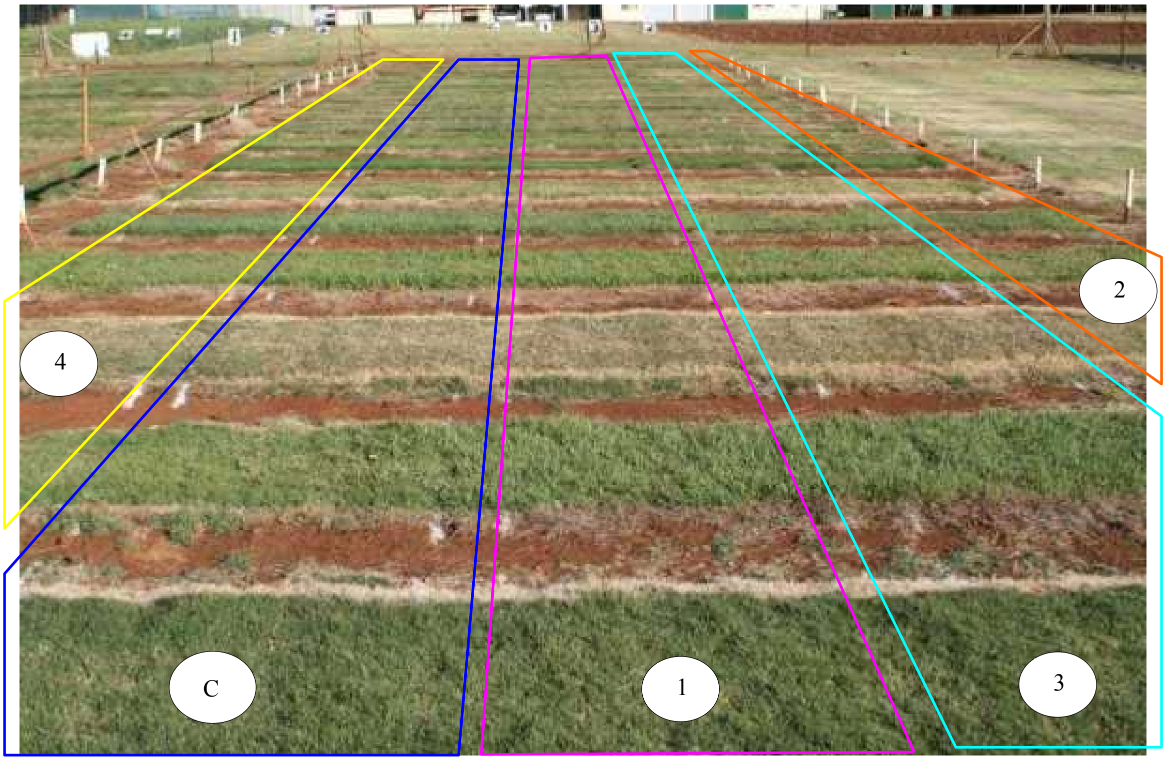
Individual plots measured 1 x 5 m which had initially been established by planting 5 individual plugs planted at 1.5 m spacings over the 5 m plot for the purposes of conducting a Plant Breeder's Rights (PBR) experiment (Roche, 2009). Plots were established 19 Jan 2010 and maintained for the purposes of conducting PBR work until 28 Oct 2010. Commencing 16 Nov 2010 all plots which had previously been unmown were mown (scalped) back to ≈20 mm in height. From the latter date to 31 Mar 2011 plots were routinely mown to produce a minimum turf quality rating of acceptable at a cutting height of 30 mm.

A strip-plot design was superimposed over the 4 block layout to trial the 4 treatments of trinexapac-ethyl and a control (no pesticide). Each subplot measured 1 x 1.5 m and contained the following treatments within each plot: a (c) control (C); (1) 500 ml/ha; (2) 800 ml/ha; (3) 1.5 L/ha and (4) 2.0 L/ha (e.g. Figure 9). Trinexapac-ethyl treatments were applied using a gas regulated walk behind spray unit on 5 Apr, 3 May, 14 Sep, 11 Oct, 9 Nov, 15 Dec 2011, 10 Jan, 1 Feb and 28 Feb 2012, during the active growing periods of the study.

Subplots were measured twice per week using a Toro® height of cut prism to monitor plant growth. If during the inspection any subplots had grown 15 mm (from 30 to 45 mm) they were identified and mown the same day. This procedure follows the 1/3 mowing rule i.e. only mow 1/3 off of the sward so as not to stress the plant. Ideally a lower desirable height of cut would have been adopted, but for community sports fields and recreational areas, due to sometimes infrequent mowing, it was decided it was appropriate to use a 30 mm height of cut.

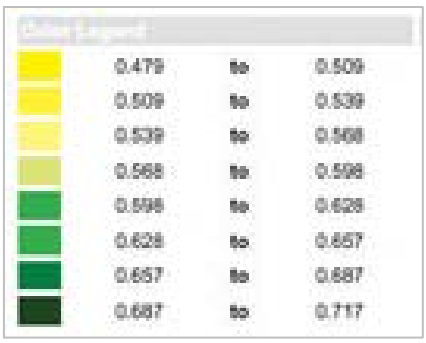
[*] variety is not commercially available within Australia or is an experimental line.

Figure 9. Photo taken of the trinexapac-ethyl (1, 500 ml/ha; 2, 800 ml/ha; 3, 1.5 L/ha; and 4, 2.0 L/ha) and control (C) subplots within Block 3 (facing south) 5 July 2011.



Once a subplot was tagged and cut (i.e. had reached 45 mm and was cut back to 30 mm) this was recorded and an average was taken across all four replications. The first recoding took place 8 Apr 2011 and observations continued twice per week until 23 Mar 2012. Following trinexapac-ethyl treatments turf colour was also assessed using the Field Scout Turf Colour Meter (TCM) 500 (Spectrum Technologies Inc., USA) approximately one week post application of treatments. The TCM portable unit itself measures reflected light from turfgrass in the red (600nm) and near infrared (850nm – NIR) spectral bands. The difference between the two values relates to the chlorophyll concentration and plant health, providing a 'Turf Colour Meter Rating'. Red & NIR data is presented in three forms: Percent reflectance (0.0 to 99.9) of Red and NIR, Normalised Difference Vegetative Index (0.000 to 1.000 – NDVI e.g. Figure 10 and Grass Index (i.e. 1.00 to 9.00). The grass index scale is comparable to the turf quality rating scale [1 (= worst) to 9 (= best); 6 = acceptable]. Assessments using the TCM were carried out on 11 occasions between 20 Apr 2011 and 7 Mar 2012. All data were analysed through GenStat® Release 14.2 for PC/Windows. Graphs were constructed using Microsoft ® Office Excel 2003. LSD values shown are at P=0.05.

Figure 10. Colour legend for NDVI (Normalised Difference Vegetative Index). Units shown are in NDVI (source: Spectrum Technologies Inc., 2012).

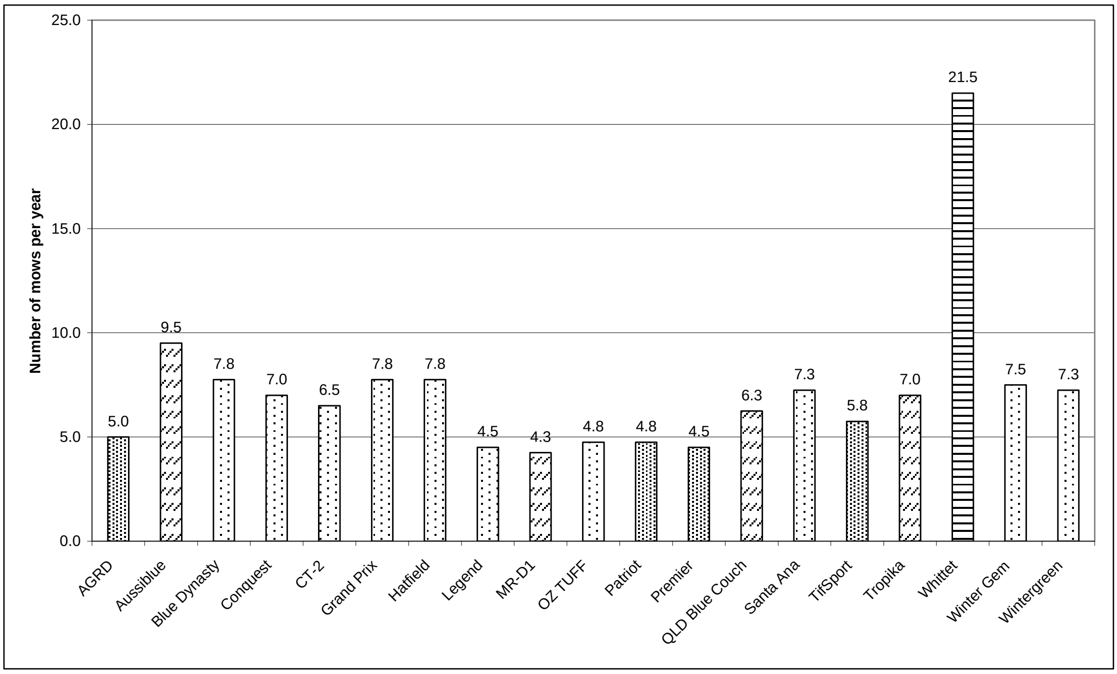


The trial was irrigated to maintain unstressed growth utilising hand shift irrigation. Fertiliser (Urea) was applied once throughout the duration of the study. Plots were separated with regular spraying of the non-selective herbicides Baster® or Finale® (glufosinate ammonium) to prevent stoloniferous contamination.

Results

In comparing the 19 varieties of turfgrass that did not have trinexapac-ethyl applied (control plots) significant variation can be seen (Figure 11), particularly between the species of turf. Annual mowing requirements of the 4 varieties of blue couch ranged from 4.3 to 9.5, whereas the 4 varieties of *Cynodon* hybrid ranged from 4.5 to 7.3, the 12 green couch varieties ranged from 4.5 to 7.8 and the single kikuyu variety, Whittet, measured 21.5 mows. The overall variation which ranges from 4.3 to 21.5 mows per year in this particular instance is a significant difference and highlights that mowing requirements will differ considerably between species but also between varieties.

Figure 11. Average number of mows per year to maintain a 35 mm height of cut of the turfgrasses trialled not undergoing trinexapac-ethyl treatments (i.e. sum of control plots only). Columns are shaded the same for cultivars within the same species.



Across the board, use of trinexapac-ethyl reduced the mowing requirements needed to maintain a turfgrass. The collection of data across all four seasons encompassing all 19 varieties of warm-season turfgrass saw on average untreated varieties required 7.2 mows per year, while a low rate of 500 ml/ha required 6.1, a rate of 800 ml/ha required 6.0, a rate of 1.5 L/ha needed 5.5 and a high rate of 2.0 L/ha required only 5.1 (Table 5). This equated to a mowing reduction of 15, 17, 24 and 29% when treated with trinexapac-ethyl treatments 1 to 4 respectively. However, some grass varieties, particularly the *Cynodon* hybrids reacted adversely to the higher application of trinexapac-ethyl resulting in stunting and distorted growth (e.g. Plate 5), whereas a low or high rate of trinexapac-ethyl seemed to have no effect on plant height reduction or canopy tightening of the kikuyu variety in the subtropical test location at Redlands Research Facility.

Table 5. Average number of mows required throughout each season within 2011-2012 following the application of trinexapac-ethyl treatments (1, 500 ml/ha; 2, 800 ml/ha; 3, 1.5 L/ha and 4, 2.0 L/ha) and a control (C) treatment. The height of cut is 30 mm. Each subplot is identified and mown once it reaches 45 mm, therefore cutting only 1/3 of the leaf blade of each time (1/3 mowing rule).

Cultivar	Season																			
	Spring					Summer					Autumn					Winter				
	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4	C	1	2	3	4
AGRD	2.0	1.3	1.3	1.3	1.0	2.3	2.5	2.0	2.3	1.5	0.8	0.8	0.3	0.3	0.3	-	-	-	-	-
Aussiblue	3.0	2.5	1.8	2.3	1.5	3.5	3.3	3.0	3.3	3.3	2.5	1.8	2.0	1.3	1.0	0.5	-	0.3	0.5	-
Blue Dynasty	2.5	2.5	1.8	2.3	1.8	3.3	2.0	2.5	2.3	1.5	1.5	1.3	0.8	0.8	1.0	0.5	0.3	0.3	-	-
Conquest	3.0	2.5	2.8	1.3	1.3	2.8	2.0	2.3	1.8	2.0	1.3	1.0	1.3	0.8	0.3	-	-	-	-	-
CT-2	2.0	2.0	2.0	1.5	2.5	2.5	2.5	2.0	1.5	2.5	1.0	0.8	0.8	0.5	0.8	0.5	0.5	-	-	-
Grand Prix	3.0	2.0	1.3	2.0	1.3	3.3	2.5	2.8	2.3	1.8	1.3	1.0	1.0	0.8	0.8	0.3	0.3	0.3	0.3	-
Hatfield	3.0	3.0	2.8	1.8	2.0	4.0	2.8	3.0	3.3	2.5	0.8	0.8	0.8	0.3	0.8	-	-	-	-	-
Legend	2.3	1.5	2.0	1.0	1.3	1.8	1.8	1.5	0.5	1.3	0.3	-	0.3	0.5	0.3	0.3	-	-	-	-
MR-D1	1.3	1.0	0.5	1.3	0.8	1.8	1.3	1.0	0.8	1.0	1.0	1.0	0.8	0.8	0.8	0.3	0.3	0.3	-	-
OZ TUFF	1.8	1.8	2.0	1.3	1.0	2.3	2.3	2.3	2.0	1.8	0.8	0.5	0.3	0.3	0.3	-	-	-	-	-
Patriot	2.5	1.0	1.0	1.8	1.8	2.3	2.0	2.0	1.8	1.5	-	0.3	0.5	0.3	0.5	-	-	-	-	-
Premier	1.5	1.8	1.3	1.0	1.0	1.8	1.8	1.0	1.5	1.0	1.3	0.8	0.8	1.0	0.3	-	-	-	-	-
QLD Blue Couch	2.0	1.3	0.5	0.8	0.8	2.0	2.0	2.3	1.8	1.8	1.8	1.0	1.5	1.3	1.0	0.5	0.5	1.3	1.0	0.8
Santa Ana	2.5	2.3	2.3	2.3	2.0	2.3	2.5	3.0	3.0	2.5	1.3	1.8	1.0	0.5	1.5	0.3	0.3	-	-	-
TifSport	2.5	2.3	2.8	2.0	1.8	2.3	2.0	2.8	1.8	2.0	0.8	0.5	0.5	0.5	0.8	0.3	-	-	-	-
Tropika	1.8	1.8	2.0	1.5	0.5	3.0	2.5	2.5	3.0	2.3	2.0	1.5	1.5	1.5	1.8	0.3	0.5	0.5	-	-
Whittet	6.5	6.5	6.0	5.8	5.5	5.8	5.5	5.5	5.8	5.8	6.5	7.5	7.3	7.8	7.8	2.8	2.8	2.8	2.8	3.8
Winter Gem	2.8	2.8	2.0	1.8	2.0	3.0	2.5	3.0	2.0	1.3	1.3	0.8	0.5	0.8	0.8	0.5	0.3	-	0.3	-
Wintergreen	2.3	2.8	2.3	2.0	1.8	2.8	2.5	3.5	2.5	2.5	1.8	0.5	0.8	0.3	0.3	0.5	-	0.3	-	-
Average	*2.5*	*2.2*	*2.0*	*1.8*	*1.7*	*2.8*	*2.4*	*2.5*	*2.3*	*2.1*	*1.5*	*1.2*	*1.2*	*1.1*	*1.1*	*0.4*	*0.3*	*0.3*	*0.3*	*0.2*

Notes: Established plots were mown routinely until 31 March 2011; trinexapac-ethyl treatments were applied on 5 Apr, 3 May, 14 Sep, 11 Oct, 9 Nov, 15 Dec 2011, 10 Jan, 1 Feb and 23 Mar 2012; spring: 1 Sep to 30 Nov 2011, summer: 1 Dec 2011 to 29 Feb 2012, autumn: 1 Apr to 31 May 2011, and winter: 1 Jun to 31 Aug 2011; -, on average no mowing was required.

Plate 5. trinexapac-ethyl applied at the higher rate of 2.0 L/ha caused distortion to the foliage of some of the green couch and *Cynodon* hybrid varieties throughout the duration of the study. The damage seen is similar in appearance to the damage caused by eriophyid mites (e.g. *Aceria cynodonis*).

Use of the Turf Colour Meter is becoming more widely adopted within the turf industry today. This is because it takes away the bias or colour variation seen from one person inspecting the turf and another. Turf Colour Meter data from the medium- to coarse-textured varieties was collected on 11 occasions throughout the study. The Mean Grass Index values (Figure 12) provide an indication that turf quality was above acceptable (≥6) on 10 of the 11 testing dates, but not in February 2012. There was no statistical difference in the Grass Index rating between treatments (mean range 6.35 and 6.39). Likewise little variation in Grass Index was observed at between the species, with blue couch recording on average (across all treatments) 6.37, green couch 6.39, *Cynodon* hybrid 6.35 and kikuyu 6.22.

NDVI values are very much transparent with Grass Index values, however they are not identical (R^2=0.98) as seen within the 1480 data sets collected from within the medium- to coarse-textured varieties and subplots. Overall, no variation within treatments can be seen within the NDVI values collected (mean NDVI of 0.62) over the course of the study. Only the green couch and kikuyu varieties deviated 0.01 higher than the mean value. When comparing the mean values at the species level (0.62-0.63) to the NDVI colour legend (Figure 10) it shows that an acceptable colour is observed compared with a dark green appearance (e.g. NDVI of ≥0.657).

Figure 12. Mean Grass Index figures of the 19 medium- to coarse-textured warm-season turfgrasses trialled for treatments 1 (500 ml/ha), 2 (800 ml/ha), 3 (1.5 L/ha), 4 (2.0 L/ha) and the control (C) over the eleven test dates using the Turf Colour Meter.

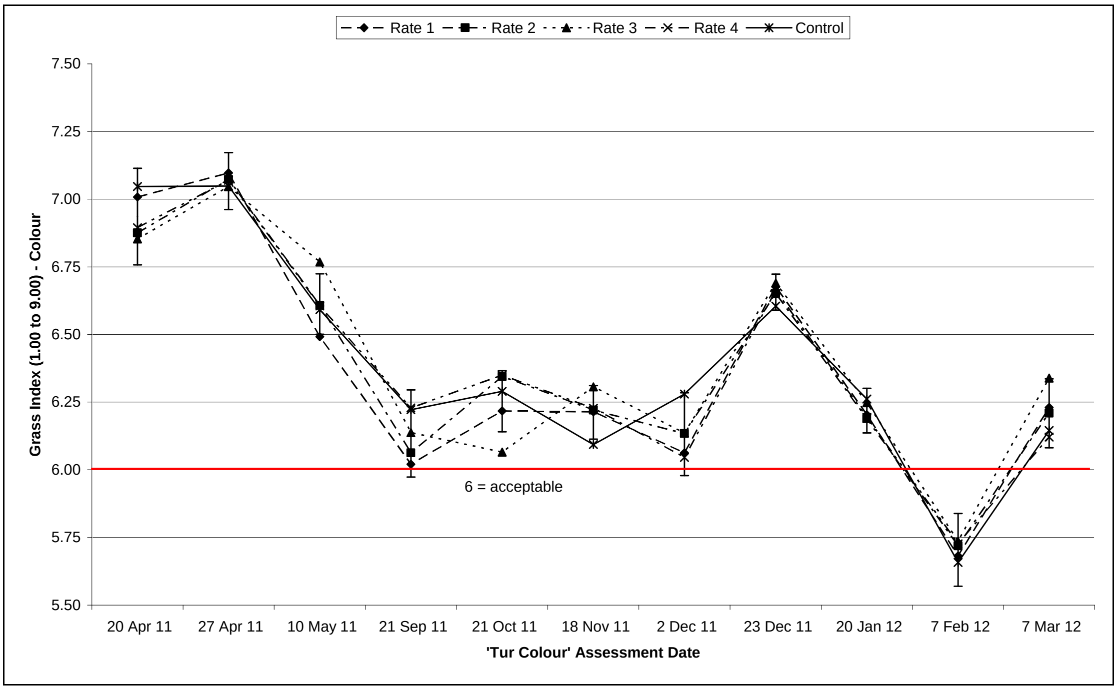
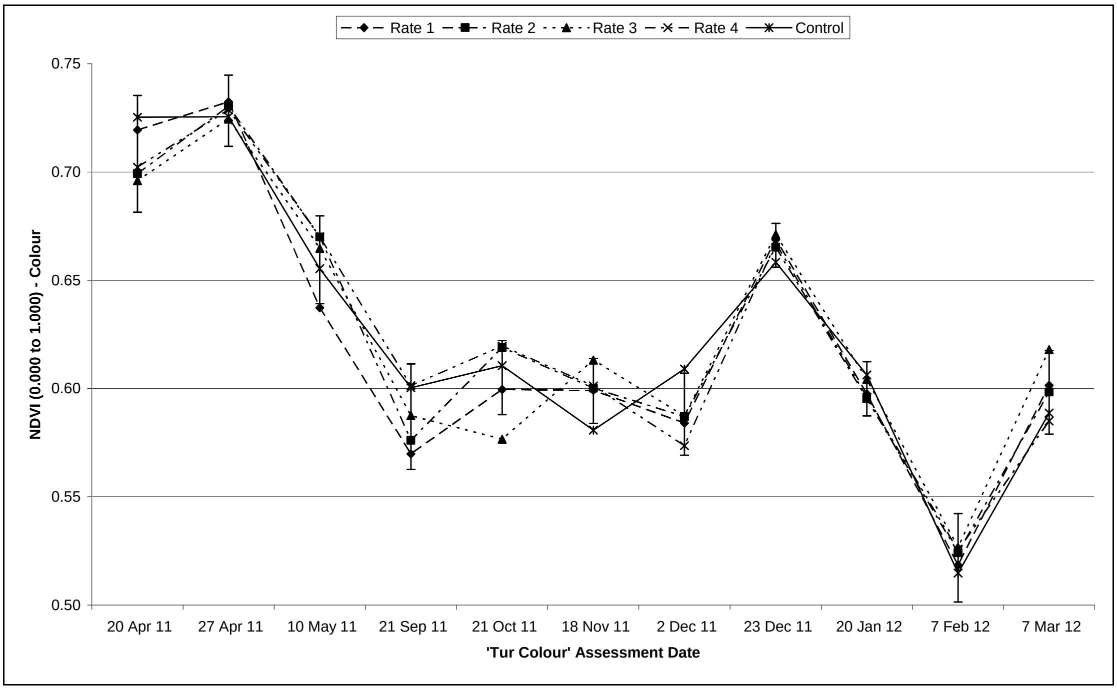


Figure 13. Mean NDVI figures of the 19 medium- to coarse-textured warm-season turfgrasses trialled for treatments 1 (500 ml/ha), 2 (800 ml/ha), 3 (1.5 L/ha), 4 (2.0 L/ha) and the control (C) over the eleven test dates using the Turf Colour Meter.



Discussion

Use of growth regulators like trinexapac-ethyl can provide turf managers with an opportunity to save resources and potentially improve turf quality should the pesticide perform as intended. Trinexapac-ethyl with an active constituent of 120g/L is designed to growth regulate a turf sward and reduce mowing requirements. A leading chemical company suggests that use of trinexapac-ethyl can potentially reduce clippings by 20 to 50% over a 2 to 6 week period when using the PGR at recommended rates. The data acquired over a twelve month period from 19 varieties of warm-season turfgrass varieties trialled in South East Queensland shows that a reduction between 15 and 29 % is possible when utilising particular application rates as per this study.

The mowing requirements of kikuyu were the highest of all species and or varieties trialled. Mean seasonal value put untreated (control) plots requiring on average 21.6 mows per year, whereas using trinexapac-ethyl at either 500 ml/ha, 800 ml/ha, 1.5 L/ha or even 2.0 L/ha had no effect on growth reduction (decrease in mowing requirements). An annual mowing program at the latter rates would equate to 22.3, 21.6, 22.2 and 22.9 mows required respectively to maintain a 30 mm height of cut. The Primo Maxx® label produced by Sygenta® recommends an application rate of 2 to 8 L/ha for kikuyugrass. The following range should be adopted and monitored to assess its performance given the little benefit DAFFQ researchers had in using a pesticide rate of ≤2.0 L/ha.

During field inspections it was observed that some phytotoxic damage including stunt of stem and leaf growth and discolouration was observed following the routine application of (higher) trinexapac-ethyl treatments (e.g. 1.5 and 2 L/ha). Due to limited funding resources, phytotoxic data was not collected across the range of green couch, *Cynodon* hybrid, blue couch and kikuyu varieties. It is recommended that further work be undertaken across a range of cultivars and environments (GxE) to determine safe pesticide rates for range of situations (e.g. parks, ovals, general grasses areas).

It is noted on the Primo Maxx® Sygenta® label that to some extent, application rates will need to be adjusted to match growing conditions, management practices and the amount of growth regulation required by the turf manager. This is a significant point to make and turf managers should monitor their conditions regularly when using growth regulators.

3. Redlands Touch Association (RTA)

Introduction

Touch Football Australia is jostling to position touch football as Australia's leading community sport. Within Australia there are over 399,000 registered Touch players with approximately 500,000 school children playing the sport. Of the 370 identified Touch Associations [NSW (165), QLD (101), WA (34), SA (19), VIC (29), ACT (8), TAS (7), and NT (7)] registered with Touch Football Australia, the majority of these clubs run men's, women's and mixed competitions at both a social and competitive level 5-7 days per week. It is Touch Football Australia's mission to have in excess of 500,000 registered or known participants playing touch football by 2015 (TFA, 2011). An increase of this nature will undoubtedly place noticeable strain on the sports turf surface at these clubs if their facilities are not kept to an acceptable standard.

In 2009, the Department of Agriculture, Fisheries and Forestry Queensland (DAFFQ) turf research team was approached by Laurence Blacka; the Turf Services Officer within Redland City Council (Cleveland, Queensland, Australia) to investigate turf varietal options for their council leased Showgrounds Complex housing the Redlands Touch Association (RTA). The RTA is faced with 24 games of touch football across their 6 fields each night of competition. The club, including groundkeeper Darryl Hoffman wanted to identify a better suited turfgrass that could handle wear and tear incurred from the clubs fixtures and multi-use events being conducted across the fields.

In light of Councils request it provided an excellent opportunity to establish a trial site at the RTA along with a simulated wear study at Redlands Research Facility (refer to chapter 3) (RRF). This provided an excellent opportunity for DAFFQ researchers to assess and compare traffic stress incurred between simulated wear and actual wear through the playing of touch football games.

Additional aims of the project was to assist Redland City Council and the RTA at identifying potential turfgrasses that provided greater wear tolerance, uniformity and require lower maintenance requirements (e.g. mowing) to suit their playing schedule and budget. Researchers also wanted to provide evidence on what their current decompaction program was achieving verses a more regular program and how such an increase could offer surface hardness relief.

The chapter is broken up into two sections: Phase 1 – where studies were undertaken across fields 3 and 4 between 9 Jan 2009 and 26 May 2011; and Phase 2 – which incorporated wear and decompaction studies, among other parameters, on fields 5 and 6 between 3 Dec 2009 and 23 Mar 2012.

Phase 1 (fields 3 and 4) – Actual Wear Study

Material and Methods

Trial plots were established across two touch football fields at the Redlands Touch Association (RTA) (27°32'S lat, 153°15'E long, 12 masl), Cleveland, Queensland, Australia, to formally assess actual wear across difference turf varieties. The randomised block design, with 4 replications had two blocks positioned centrally on each field (fields 3 and 4); one either side of halfway (Figure 14). Plots established across playing fields 3 and 4 were identified as Phase 1 of 2 for the RTA study. Each phase ran for a 2 year period.

Figure 14. Location of Phase 1 (indicated by the red squares) on playing fields 3 and 4 and Phase 2 (indicated by the yellow squares) on playing fields 5 and 6 at the Redlands Touch Association touch football fields. Each phase had 4 replicates or blocks.

Plots within each block measured 20 x 2 m containing 6 varieties of *Cynodon dactylon* (green couch) cultivars including 'C1' (marketed as Legend®), 'Grand Prix', 'Hatfield', OZ TUFF™, 'Riley's Evergreen' (marketed as Conquest™) and 'Wintergreen'. Each subplot measured 6.6 x 2 m. All 6 cultivars were laid as unwashed sod between 7 and 9 Jan 2009. The remaining area of the playing field was planted with the *C. dactylon* x *C. transvaalensis* (*Cynodon* hybrid) cultivar TifSport™ (Tift 94) using jumbo rolls. Data was also collected from this cultivar, but as it was not included in the randomised block design the figures should not be compared against the 6 green couch varieties.

Superimposed over the basic randomized block experiment was a strip-plot design to accommodate 3 decompaction treatments. They included D1 (decompaction ≈ once per year), D2 (decompaction ≈ bi-annually) and D6 (decompaction ≈ at six-week intervals). It was not possible to have a control (no decompaction) due to safety and the need for the surface to remain consistent under foot.

Unlike a simulated wear study, you are unable to control wear distribution uniformity imposed by players or the amount of wear being applied (games played) because of scheduled fixtures. Between 27 Apr 2009 and 26 May 2011 approximately 1445 regular games (e.g. not carnivals) were played on each playing field, numbers 3 and 4 (Table 6).

Table 6. Approximate number of touch football games being played on each of the two fields, 3 and 4, of the RTA trial site between 27 Apr 2009 and 26 May 2011 for Phase 1 of the study. Calculations are based on 17 games per week per field.

Period	Number of weeks	Total games for each period
27 Apr 2009 to 28 Aug 2009	18	306
14 Sep 2009 to 4 Dec 2009	12	204
1 Feb 2010 to 18 Jun 2010	20	340
19 Jul 2010 to 27 Aug 2010	6	102
6 Sep 2010 to 10 Dec 2010	13	221
31 Jan 2011 to 26 May 2011*	16	272
TOTAL	**85**	**1445**

Notes: * 26 May 2011 listed above was the end date for the trial. However, the playing season ended 31 Jun 2011. Dates within each period may vary slightly from the actual playing schedule.

The D1, D2 and D6 decompaction treatments were applied 3, 4 and 8 times respectively throughout the duration of the Phase 1 study. They were D1: 31 Aug 2009, 15 Dec 2009 and 4 Jan 2011; D2: 31 Aug, 15 Dec 2009, 18 Jun 2010 and 4 Jan 2011; and D6: 31 Aug, 20 Oct, 15 Dec 2009, 11 Mar, 18 Jun, 12 Aug, 7 Oct 2010 and 4 Jan 2011. Decompaction was undertaken with a Verti-Drain machine using 20 mm solid tynes to a depth of 150 mm with (usually a) 3 % kick. Inclement weather and the availability of the decompaction machine often stretched the dates between applications.

Visual assessments of turf quality [1 (=worst) to 9 (= best); 6 = acceptable] and percentage bare ground of the sub-plots were made generally fortnightly by 1, 2 or 3 independent assessors to follow the effects of wear and surface harness through applying decompaction treatments (D1, D2, D6) throughout Phase 1 of the study. Surface hardness was assessed using a 2.25 kg Medium Clegg Impact Soil Tester (Dr

Baden Clegg, WA) (1st and 4th drops from a height of 303 mm and 457 mm were taken; however, primarily the 4th drop at 457 mm will be discussed within this report) almost monthly of each subplot throughout the duration of study. Traction testing was conducted on 17 occasions using the Redlands Automated Traction Tester (as detailed in Roche *et al.*, 2007 and herein referred to as the Redlands Traction Tester). Percentage moisture using a Field Scout® TDR 300 Soil Moisture Probe (Spectrum Technologies, Inc., USA) was used to take three readings per subplot. Turf colour was also assessed using the Field Scout® Turf Colour Meter 500 (Spectrum Technologies Inc., USA). A single measurement per subplot was collected each day of testing (data not included in this report). Inflorescence ratings (presence of seedheads) were also reported on two occasions within Phase 1 of the RTA study 16 Apr 2009 and 5 Jan 2010. It was a random decision to observe and note the presence of seedheads within the plots [0 (= no seedheads) to 9 (= prolific seedheads present)].

The playing fields were well-fertilised, irrigated routinely to maintain "unstressed" growth, top dressed annually, utilised selective herbicide for weed control, and mown regularly (to 20 mm) to simulate provide a safe and aesthetic sportsfield. Soil samples were taken annually and sent to the AGCSATech laboratory for comprehensive soil testing.

All data were analysed through GenStat® Release 14.2 for PC (Windows/XP) using standard Analysis of Variance procedures, which also generated Fisher's protected Least Significant Differences (LSDs) for comparison of treatment means. Graphs were constructed using SigmaPlot® Version 11.1 and Microsoft® Office Excel 2003.

Results

Over the duration of the study at RTA independent assessors undertook some 72 formal assessments of subjective turf quality within Phase 1 of the study (Figure 15). All varieties evaluated produced a higher turf quality rating following planting but prior to the implementation of the irrespective decompaction treatments. The latter would not be a result of the treatments themselves, but the timing upon which the turf was installed. Planting of the trial and the surrounding fields was completed in Jan 2009, but the first ratings were not conducted until May just prior to the onset of cooler temperatures, resulting in the drop in turf quality at this time. Variation in turf quality as expected can be seen during times of distinct climatic changes throughout the course of the study.

Mean quality observed for the entirety of the study ranged between 4.9 and 6.7. Continually the lowest value was that recorded by Legend. On the 4 Jan 2011, just prior to the Brisbane floods, the turf quality of Legend was a mere 1.8 out of 9 (6 = acceptable). During the same period, the remaining 5 green couch varieties recorded a turf quality rating between 4.4 (Grand Prix) and 6.7 (Hatfield). Even following the Brisbane floods, all varieties remained above acceptable (6.5 to 7.6), whereas Legend averaged only 5.8.

Turf quality between decompaction treatments resulted in little to no difference. However, assessments of the D2 (biannual) treatments resulted in consistently lower or at best equal turf quality with the D1 (annual) treatments; but the variation was not statistically different at any stage.

Figure 16. Subjective turf quality rating [1 (= worst) to 9 (= best); 6 = acceptable) acquired during assessments of turf cultivars on fields 3 and 4 at the Redlands Touch Association between 10 November 2009 and 26 May 2011.

	Phase 1 (fields 3 and 4)				
Cultivar	**Control**	**D1**	**D2**	**D6**	**Mean**
Conquest	6.5	5.9	5.5	5.9	5.9
Grand Prix	7.2	6.5	6.4	6.5	6.6
Hatfield	6.9	6.2	6.1	6.2	6.3
Legend	5.7	4.6	4.6	4.8	4.9
OZ TUFF	6.9	6.6	6.6	6.6	6.7
Wintergreen	6.5	6.3	6.2	6.4	6.3
LSD (P=0.05)	*0.07*	*0.2*	*0.2*	*0.1*	*0.1*
TifSport	7.3	6.1	5.9	6.4	6.6

<u>Notes</u>: Control: before starting decompaction work (9 Jan to 30 Aug 2009); D1 & D6: 31 Aug 2009 to 26 May 2011; and D2: 15 Dec 2009 to 26 May 2011. TifSport data was collected; however, it is not statistically part of the trial and therefore should not be compared against the other cultivars.

Significant cultivar variation was observed within Phase 1 of the study in relation to wear tolerance and recovery (Table 9). Damage was exacerbated as a result of inclement weather throughout the course of the study, but especially in Nov 2009, between Aug and Oct 2010 and in early 2011 (Figure 17). Wear and damage to the turf surface was worsened at these times because of surface compaction and ponding of rain water on the surface. Such conditions, followed by up to 17 games per week are a recipe for disaster with the potential of causing short- and/or long-term damage to the field. During Jan 2011 extreme damage (up to 79 % bare ground) was observed prior to the peak of the Brisbane Floods.

Over the course of the study all but 1 variety experienced greater than 15 % wear as observed during assessments; this was the "industry standard" Wintergreen variety. OZ TUFF, Hatfield and Grand Prix resulted in having ≥ 15 % bare ground between 1 % and 6 % of the trial period. The worst two varieties were Conquest and Legend which resulted in having an unacceptable surface for 13 % and 40 % of the playing season.

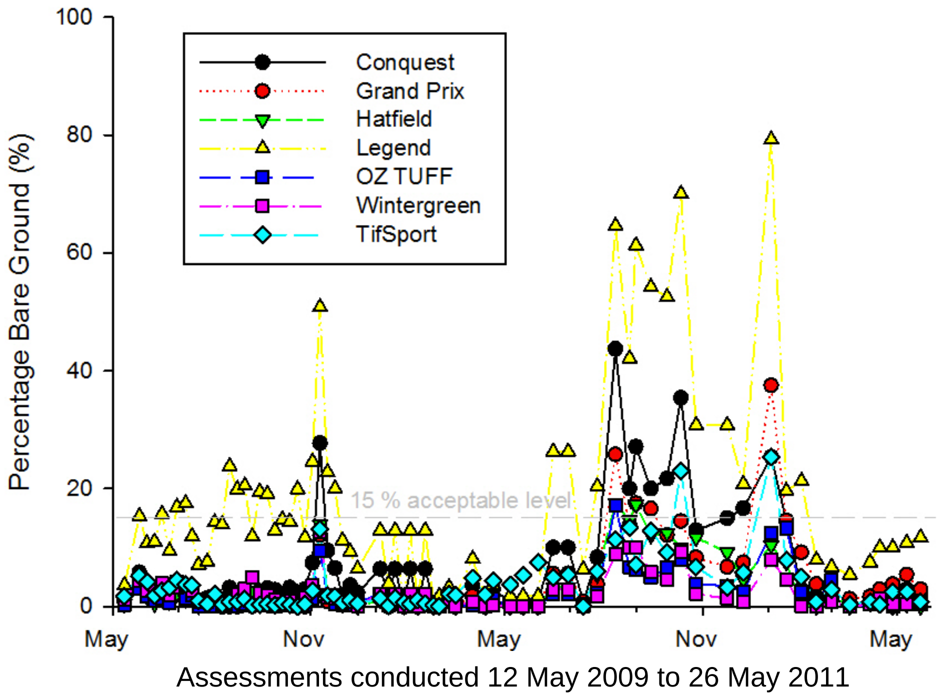
Even with the 'blowouts' (maximum bare ground) as a result of rainy periods and the decision to keep the fields in play, turf recovery was excellent for each variety with the exception of Legend in this instance. Mean (bare ground) damage was between 2 % and 6 % for Wintergreen, OZ TUFF, Hatfield, Grand Prix and Conquest. Conquest however, ranked just outside the earlier 4 varieties in terms of mean wear tolerance ranking over the Phase 1 study. Wintergreen, OZ TUFF, Hatfield and Grand Prix ranked a number 1, while Conquest was just outside at 5 and Legend was after everything else at 6.

Table 7. The amount of wear (bare ground) observed following analysis of collected data (Control, D1, D2 and D6 plots) from within Phase 1 (fields 3 and 4) of the RTA wear study between 2009 and 2011. With the exception of wear tolerance, data are expressed as percentages.

	Phase 1 (fields 3 and 4)			
Cultivar	**Time when wear is ≥ 15%**	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Conquest	13	6	44	5
Grand Prix	6	4	38	1
Hatfield	3	3	18	1
Legend	40	18	80	6
OZ TUFF	1	2	17	1
Wintergreen	0	2	13	1
LSD (P=0.05)	-	*2*	-	-
TifSport	3	4	25	-

Notes for Table 9 on the previous page and Figure 24 below: TifSport wear data was collected. However, it is not statistically part of the trial i.e. was not randomised within the complete block design at the request of Redland City Council. The variety was on the remainder of the two fields, surrounding the trial area. Data was collected between 12 May 2009 and 26 May 2011 with 72 assessments conducted during this period. * Wear tolerance ranking is based on mean percentage bare ground over the latter period.

Figure 17. Mean combined (Control, D1, D2, D6) percentage bare ground rating undertaken of fields 3 and 4 (Phase 1) between 12 May 2009 and 26 May 2011.



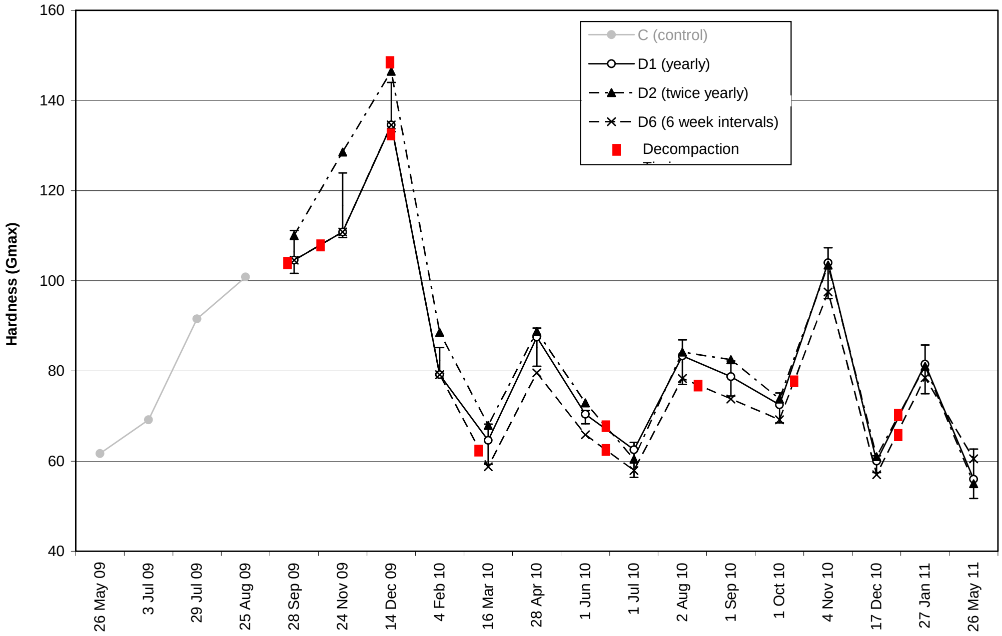
A significant component of the study was to assess surface hardness and see how council practices compared with more frequent amelioration activities. Henderson *et al.* (2007) reported that a surface hardness (Gmax) value for community sportsfields of 70-80 is ideal, ≥ 120 is concerning and ≥ 200 is dangerous, while also being the upper limit where in *head injury risks are doubled*.

Only on two testing days was surface hardness above the concerning level of 120 Gmax (Figure 18). This was for the D2 treatment on the 24 Nov 2009, prior to the 2nd decompaction for D2 and for all treatments on the 14 Dec 2009. Immediately after the latter high Clegg Impact readings (15 Dec 2009), surface decompaction was undertaken of all decompaction treatments (D1, D2, D6) and major field renovations were undertaken on the 21 Dec 2009. The turf renovation practices included a heavy sand topdressing of 7-10 mm and the field was left to recover until 1 Feb 2010 when the new touch football season commenced.

Looking at the surface hardness data collected throughout Phase 1 of the RTA study no clear pattern can be observed in compaction relief having provided verti-draining applications (Figure 18) i.e. Gmax value did not consistently decline following verti-draining activities.

From the commencement of the 2010 season until the conclusion of the Phase 1 study, Clegg Impact readings remained relatively median, between 55 and 89 Gmax. At the same time the D6 treatment produced continually lower readings than the D1 and D2 treatments. However, the D6 Clegg readings were short of being significantly significant (Figure 18).

Figure 18. Surface hardness (Gmax of 70-80 is ideal, ≥ 120 is concerning) of turf treatments (Control, D1, D2 and D6) from Phase 1 of the RTA trial. Gmax values shown are of the 4th drop from a 457 mm height.



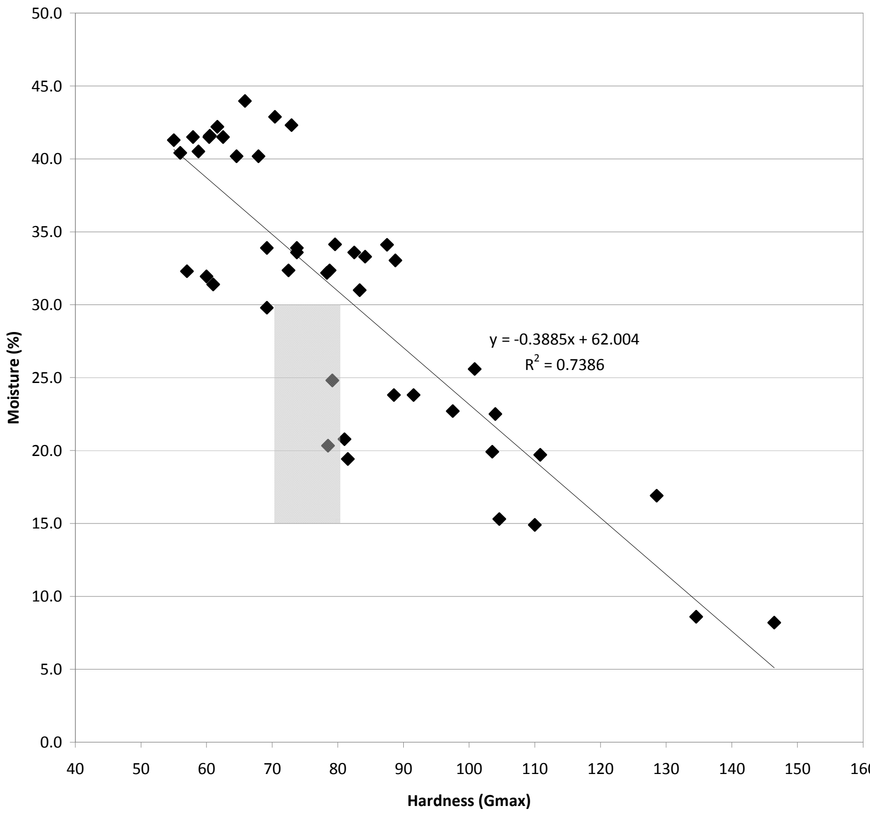
Notes: Control: before starting decompaction work (9 Jan to 30 Aug 2009); D1 & D6: 31 Aug 2009 to 26 May 2011; and D2: 15 Dec 2009 to 26 May 2011. Decompaction times are highlighted with red squares.

As part of recommendations by Henderson *et al.* (2007) to reduce surface hardness, they identified that along with regular decompaction work, moisture levels need to be monitored because they provided a strong correlation with influencing surface hardness. Their studies which were conducted across a range of premier and community tiered Queensland Australian Football League (QAFL) sportsfields within South East Queensland, showed that soil moisture levels between 15 % and 30 %, depending on the soil type, field usage etc., resulted in providing an acceptable surface hardness i.e. Clegg Impact readings were between 70 and 80 G_{max}.

Within Phase 1 of the RTA study there was a strong to high negative correlation (r = -0.86 or R^2 = 0.74) between surface hardness and percentage soil moisture i.e. the negative correlation indicates that as soil moisture increases, surface hardness decreases, and vice–versa (Figure). These results mirror the importance of monitoring and determining suitable moisture levels of a field to determine the applicable surface hardness criteria.

Two prime examples of the correlation between soil moisture and surface hardness can be seen in Figure 26; where the lowest mean soil moisture vale observed was 8.2 %, surface hardness was 146.5 G_{max}. At the other end of the spectrum 62 % of mean moisture values were above 30 % and surface hardness was between 55 and 89 G_{max}.

Figure 19. Correlation between soil moisture and surface hardness from the mean data collected within the Control, D1, D2 and D6 subplots of fields 3 and 4 between 9 Jan 2009 and 26 May 2011. The recommended range (Henderson *et al.*, 2007) is highlighted in grey.

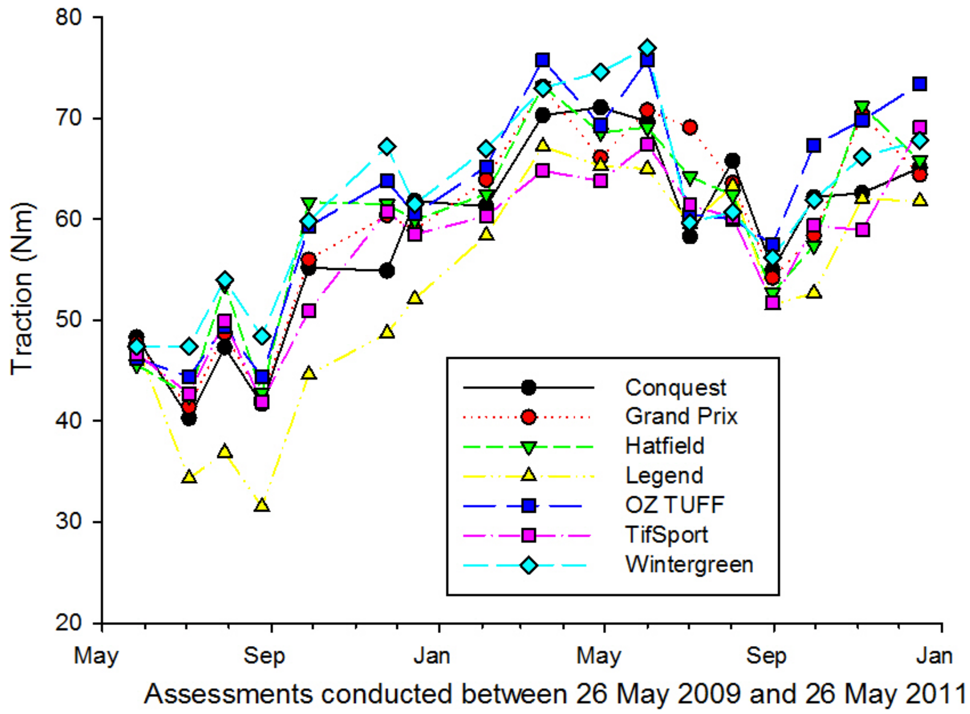


Traction (Nm) data was collected on 17 occasions between 26 May 2009 and 26 May 2011 of fields 3 and 4 (Figure 20). Following the first traction tests conducted 137 days post planting, mean traction values were 47 (±1.3) Nm. Immediately following this the winter period saw a decline in traction across all cultivars, but Legend was more noticeable than the others. The lower traction value of Legend throughout the duration of the study is comparable to the decline in percentage bare ground (Figure 17).

The highest traction value recorded was that of Wintergreen (77 Nm) in Jun 2010. Wintergreen consistently produced higher traction values throughout the winter testing periods. This is likely due to be influenced by the varieties cold tolerance and its ability to continue growing longer than other varieties entering the cooler months of the year. This can be seen in turf quality too, as Wintergreen holds a darker green colour longer before the onset of winter.

A downfall of Wintergreen is its morphological-agronomic ability to profusely seed (produce inflorescence). On two occasions throughout the Phase 1 study Wintergreen produced significantly more than any other variety (Table 8). The cultivars that produced the lowest number of inflorescence were Grand Prix and OZ TUFF.

Figure 20. Traction (Nm) values of plots prior to any treatments being imposed (31 Aug 2009) and combined D1, D2 and D6 treatments within fields 3 and 4 of the RTA study. Traction data was collected using the Redlands Automated Tester on 17 occasions between 26 May 2009 and 26 May 2011.



Note: TifSport data was collected. However, it is not statistically part of the trial and should not be compared against other varieties in the study.

Table 8. On two occasions, 16 Apr 2009 and 5 Jan 2010, ratings were given to each variety to identify the presence of seedheads (0 = no seedheads, 9 = prolific seedheads present) which will ultimately effect turf management and mowing requirements.

Cultivar	16 Apr 2009	5 Jan 2010	Ranking
Conquest	5.5	8.0	4
Grand Prix	0	1.0	1
Hatfield	3.0	4.3	3
Legend	6.8	7.3	4
OZ TUFF	1.8	1.5	1
Wintergreen	9.0	7.5	6
LSD (P=0.05)	*1.5*	*1.2*	-
TifSport	0.3	0	-

Notes: For data collected on the 16 Apr 2009, plots were last mown prior to sand topdressing on 26 Mar 2009. The fields were not mown between the latter two dates because of this renovation and frequent and heavy rainfall experienced during this time. TifSport data was collected; however, it is not statistically part of the trial and therefore should not be compared against the other cultivars. Ranking is based on the sum of data collected from the two testing dates.

Discussion

Across fields 3 and 4 (Phase 1) approximately 1,445 touch football games were played across each of the two fields between 27 Apr 2009 and 26 May 2011. This equated to 17 games per week and did not take into account school or sports carnivals that were played at the venue.

The usage or wear resulted in a near or above acceptable standard in turf quality for the entirety of the trial of all cultivars with the exception of Legend. The latter cultivar averaged a turf quality rating of only 4.9 and at its worst it scored as low as 1.8 around the time of the 2011 Brisbane Floods. The poor turf quality ratings mirrored the percentage bare ground ratings. At the latter period percentage bare ground was observed at 80 % within plots. The drop in turf quality and spikes in percentage bare ground were commonly observed within the wet periods within the study. The latter observations highlight the need for appropriately timed field closures during inclement weather.

Legend provided consistently poor turfgrass quality and percentage bare ground figures throughout the duration of the study in this instance. As a result, a decision was made by turf managers from RTA and Redland City Council not to include the latter cultivar in further trial work (Phase 2) and to remove the poorer performing variety from the study at the end of Phase 1.

Mean wear observed throughout the course of the Phase 1 study was 5.8 %. This value is well within the recommended range of <15 % providing a field fit for play. The low mean value of less than 6 % wear was surprising given that nearly 1,500 games of touch football were played and for the duration of the trial period mean rainfall figures were above average.

Following the incorporation of all decompaction treatments, surface hardness was between 55 and 89 G_{max}, and on one occasion (Nov 2010) it reached as high has 104 G_{max}. Of the 11 occassions where all decompaction treatments were in play, only twice were surface hardness levels of the D6 (6 week intervals) treatment less than annual or biannual treatments. It's possible that the lack of variation is a result of high soil moisture (i.e. 62 % of soil moisture data was above 30 % percentage moisture) and continuous inclement weather experienced during the trial, not that of the unsuccessfulness of incorporating more frequent amelioration techniques.

Throughout the course of the study the variation in inflorescence density (presence of seedheads) between *Cynodon* spp. growing at the RTA was either formally or informally noted. In some instances the varietal differences were vast. This caused problems in terms of managing the turfgrasses and having to mow the field because some grasses were profusely seeding, while others were not. The variation influenced aesthetics but also on resources needed to keep high seeding varieties in check. The latter can be a financial burden for clubs long-term with the need for more frequent mowing.

Phase 2 (fields 5 and 6) – Actual Wear Study

Material and Methods

Trial plots were established across two touch football fields at the Redlands Touch Association (RTA) (27°32'S lat, 153°15'E long, 12 masl), Cleveland, Queensland, Australia, to formally assess actual wear across difference turf varieties. The randomised block design, with 4 replications had two blocks positioned centrally on each field (fields 5 and 6); one either side of halfway (Figure 14). Plots established across playing fields 5 and 6 were identified as Phase 2 of 2 for the RTA study. Each phase ran for a 2 year period.

Plots within each block measured 20 x 2 m containing 5 varieties of *Cynodon dactylon* (green couch) cultivars including 'Grand Prix', 'Hatfield', OZ TUFF™, 'Riley's Evergreen' (marketed as Conquest^{TM}) and 'Wintergreen', and 1 cultivar of *C. dactylon* x *C. transvaalensis* (*Cynodon* hybrid) being TifSport™ (Tift 94). The latter variety was also planted using jumbo rolls in the remaining area of the playing field. All 6 cultivars were laid as unwashed sod between 30 Nov and 3 Dec 2009 (Plate 6). The green couch cultivar 'C1' (marketed as Legend®) was not included due to the poor wear tolerance and recovery observed within Phase 1 of the RTA study. This was at the request of turf managers of Redland City Council and the RTA. TifSport took the position of Legend within the replicated trial.

Plate 6. Turf cultivars being planted within fields 5 and 6 at the RTA on 1 Dec 2009.

Superimposed over the basic randomized block experiment was the same strip-plot design as Phase 1 to accommodate the 3 decompaction treatments (D1, D2 and D6) per plot; each subplot measured 6.6 x 2 m. The D1, D2 and D6 treatments were applied 2, 4 and 6 times respectively throughout the duration of the Phase 2 study. They were D1: 12 Aug 2010 and 15 Jul 2011; D2: 18 Jun 2010, 4 Jan, 15 Jul 2011 and 22 Feb 2012; and D6: 18 Jun, 12 Aug, 7 Oct 2010, 15 Jul, 21 Oct 2011 and 22 Feb 2012. Decompaction was undertaken with a Verti-Drain machine using 20 mm solid tynes to a depth of 150 mm with (usually a) 3 % kick. Inclement weather and the availability of the decompaction machine often stretched the dates between applications.

Between 1 Feb 2010 and 23 Mar 2012 approximately 1,462 regular games (e.g. not carnivals) were played across field 5 and field 6 (Table 9).

Table 9. Approximate number of touch football games being played on each of the two fields, 5 and 6, of the RTA trial site between 1 Feb 2010 and 23 Mar 2012 for Phase 2 of the study. Calculations are based on 17 games per week per field.

Period	Number of weeks	Total games for each period
1 Feb 2010 to 18 Jun 2010	20	340
19 Jul 2010 to 27 Aug 2010	6	102
6 Sep 2010 to 10 Dec 2010	13	221
31 Jan 2011 to 17 Jun 2011	20	340
18 Jul 2011 to 2 Sep 2011	7	119
12 Sep 2011 to 9 Dec 2011	13	221
6 Feb 2012 to 23 Mar 2012*	7	119
TOTAL	**86**	**1462**

Notes: * 23 Mar 2012 listed above is the end date for the trial, however the season concluded on 26 May 2012. Dates within each period may vary slightly from the actual playing schedule.

Visual assessments of turf quality and percentage bare ground of the sub-plots were made generally fortnightly by 1, 2 or 3 independent assessors to follow the effects of wear and surface harness through applying decompaction treatments (D1, D2, D6) throughout Phase 2 of the study. Surface hardness was assessed using a 2.25 kg Medium Clegg Impact Soil Tester (1st and 4th drops from a height of 303 mm and 457 mm were taken; however, primarily the 4th drop at 457 mm will be discussed within this report) almost monthly of each subplot throughout the duration of study. Traction testing was conducted on 16 occasions using the Redlands Traction Tester and once on the 23 May 2011 using the manual Studded Boot Apparatus (Canaway and Bell,

1986) (Turf Tec Australia Manual Traction Tester). Percentage moisture using a Field Scout® TDR 300 Soil Moisture Probe was used to take three readings per subplot. Turf colour was also assessed using the Field Scout® Turf Colour Meter 500. A single measurement per subplot was collected each day of testing (data not included in this report).

The playing fields were well-fertilised, irrigated routinely to maintain “unstressed” growth, top dressed annually, utilised selective herbicide for weed control, and mown regularly (to 20 mm) to simulate provide a safe and aesthetic sportsfield. Soil samples were taken annually and sent to the AGCSATech laboratory for comprehensive soil testing.

All data were analysed through GenStat® Release 14.2 for PC (Windows/XP) using standard Analysis of Variance procedures, which also generated Fisher’s protected Least Significant Differences (LSDs) for comparison of treatment means. Graphs were constructed using SigmaPlot® Version 11.1 and Microsoft® Office Excel 2003.

Results

With the exception of Conquest, all varieties produced on average an acceptable or better turf quality rating within Phase 2 of the RTA study (Table 10). Turf quality was at its worst in Aug 2010 following ratings of the field after a heavy rain period and the fields being kept in play. The worst turf quality rating was 3.0 (Conquest) and the best was just below acceptable at 5.6 (Wintergreen).

It was observed that the D1 and D2 treatments consistently produced a higher turf quality rating than the D6 treatment over the course of the study as highlighted in Table 10 below.

Table 10. Subjective turf quality rating [1 (= worst) to 9 (= best); 6 = acceptable) acquired during assessments of turf cultivars on fields 5 and 6 at the Redlands Touch Association between 17 Mar 2010 and 23 Mar 2012.

	Phase 2 (fields 5 and 6)				
Cultivar	**Control**	**D1**	**D2**	**D6**	**Mean**
Conquest	5.9	5.9	5.8	5.5	5.7
Grand Prix	6.7	6.6	6.6	6.6	6.6
Hatfield	6.1	6.5	6.5	6.4	6.4
OZ TUFF	6.7	6.8	6.8	6.7	6.7
TifSport	6.1	6.7	6.6	6.6	6.5
Wintergreen	6.5	6.9	6.8	6.7	6.8
LSD (P=0.05)	*0.1*	*0.1*	*0.1*	*0.2*	*0.1*

Notes: Control: before starting decompaction work (3 Dec 2009 to 17 Jun 2010); D1: 12 Aug 2010 to 23 Mar 2012; D2: 4 Jan 2011 to 23 Mar 2012; and D6: 12 Aug 2010 to 23 Mar 2012.

With the exception of the wear tolerance and recovery of Conquest, the other 5 cultivars (Grand Prix, Hatfield, OZ TUFF, TifSport and Wintergreen) all demonstrated having good tolerance, but excellent recovery under the wear incurred. Following some 1,462 game of competitive touch football across each field between 1 Feb 2010 and 23 Mar 2012, the mean observed wear was only 4 % (Table 11). Damage across the plots was exacerbated as a result of inclement weather between Aug 2010 and Feb 2011 (Figure 21). During the latter period each cultivar recorded their highest (maximum) percentage bare ground rating, the worst resulting in 40 % bare ground.

Over the course of the study wear tolerance rankings grouped into 3 categories: Conquest, which was the only variety to incur greater than 15 % wear as observed during assessments; three other cultivars, Grand Prix, Hatfield and TifSport, resulted in reaching ≥ 15 % bare ground on 4 occasions each; and not once did OZ TUFF of the “industry standard” variety Wintergreen record over 15 % bare ground.

Table 11. The amount of wear (bare ground) observed following analysis of collected data (Control, D1, D2 and D6 plots) from within Phase 2 (fields 5 and 6) of the RTA wear study between 2010 and 2012. With the exception of wear tolerance, data are expressed as percentages.

	Phase 2 (fields 5 and 6)			
Cultivar	**Time when wear is ≥ 15%**	**Mean bare ground**	**Maximum bare ground observed**	**Wear tolerance ranking***
Conquest	22	10.4	40	6
Grand Prix	4	3.8	20	3
Hatfield	4	3.1	25	3
OZ TUFF	0	1.3	14	1
TifSport	4	4.0	28	3
Wintergreen	0	1.7	12	1
LSD (P=0.05)	-	*1.4*	-	-

Note: Data was collected between 17 Mar 2010 and 23 Mar 2012 with 50 assessments conducted during this period. * Wear tolerance ranking is based on mean percentage bare ground over the latter period.

Figure 21. Mean combined (Control, D1, D2, D6) percentage bare ground rating undertaken of fields 5 and 6 (Phase 2) between 17 Mar 2010 and 23 Mar 2012.

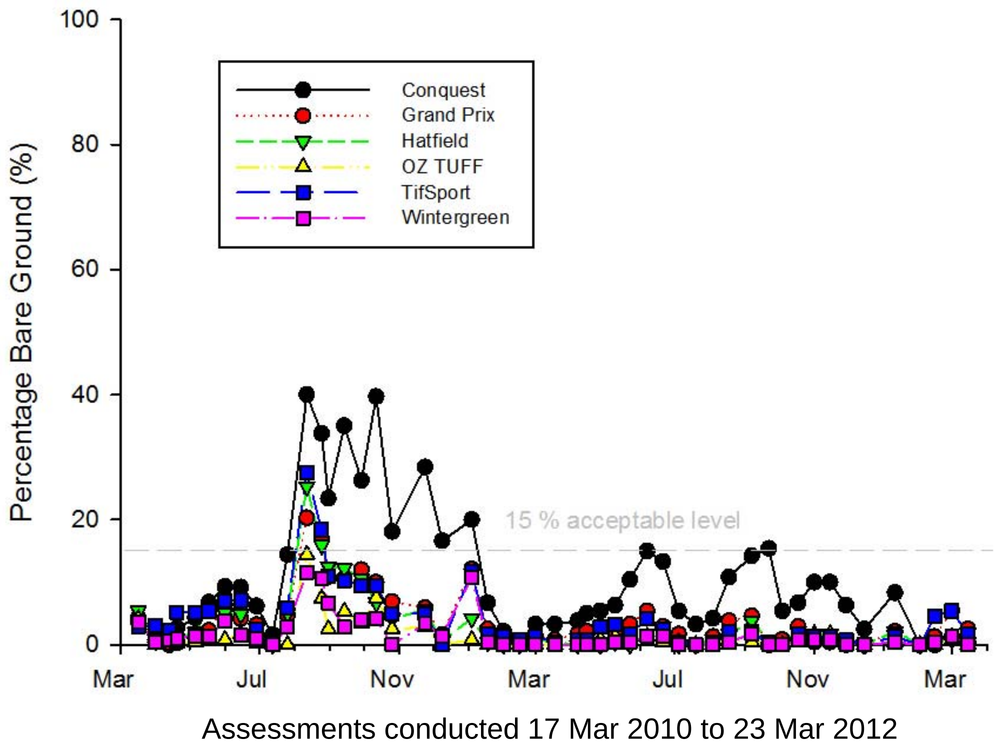
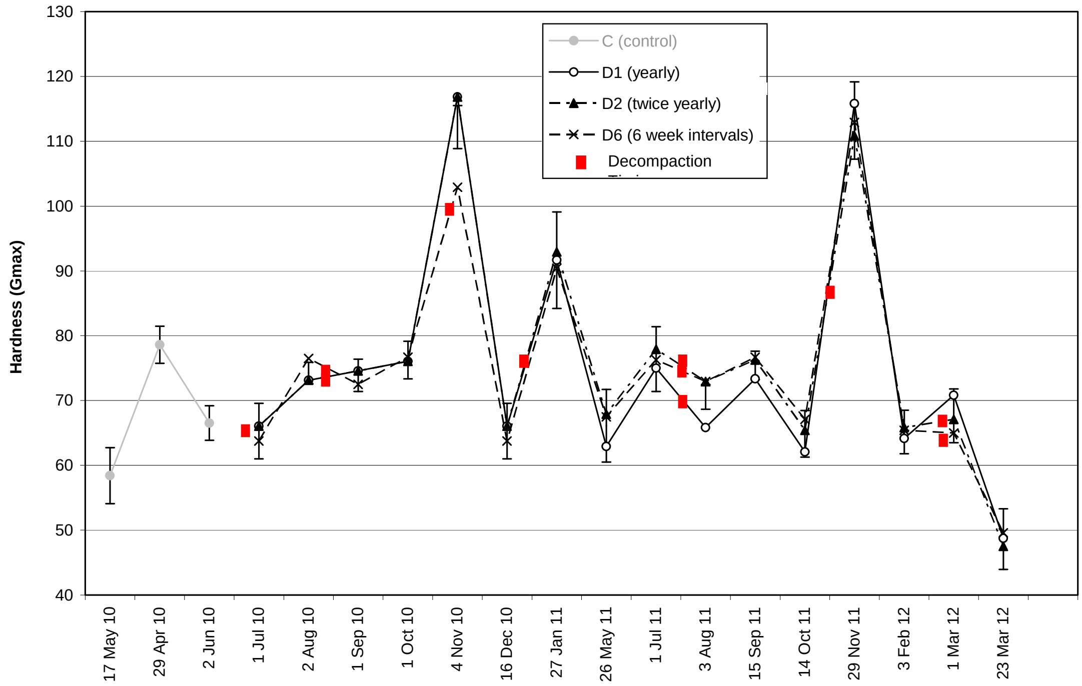


Figure 22. Surface hardness (Gmax of 70-80 is ideal, ≥ 120 is concerning) of turf treatments (C, D1, D2 and D6) from Phase 2 of the RTA trial. Gmax values shown are of the 4th drop from a 457 mm height.



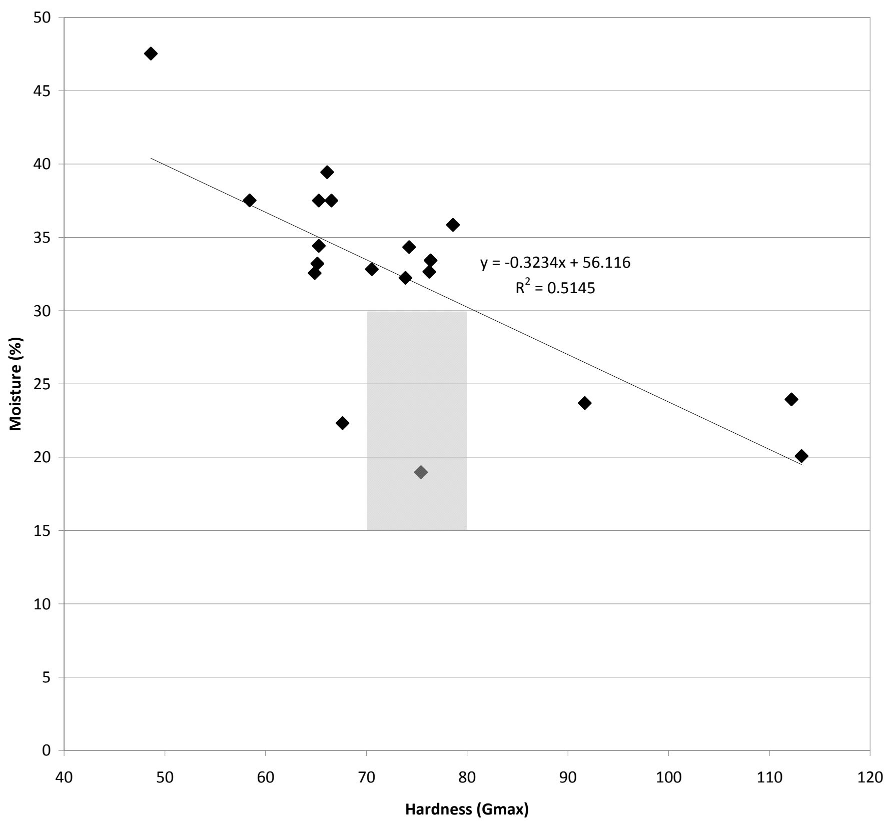
Notes: Control: before starting decompaction work (3 Dec 2009 to 17 Jun 2010); D1: 12 Aug 2010 to 23 Mar 2012; D2: 4 Jan 2011 to 23 Mar 2012; and D6: 12 Aug 2010 to 23 Mar 2012. Decompaction times are highlighted with red squares.

Henderson *et al.* (2007) reported that a surface hardness (G_{max}) value for community sportsfields of 70-80 is ideal, ≥ 120 is concerning. Over the course of the Phase 2 study, not once did hardness reach 120 G_{max} (Figure 22).

Following the incorporation of all decompaction treatments (the second D2 treatment) in Jan 2011 no clear pattern can be observed in compaction relief having provided verti-draining applications (Figure 22) i.e. G_{max} value did not consistently decline following verti-draining activities. Of the 16 occasions when hardness data was collected and the D1, D2 and D6 decompaction treatments had been applied, only twice, 2 Aug and 4 Nov 2010, was the surface hardness within the D6 treatments significantly lower than the annual (D1) and biannual (D2) treatments.

There is a strong to high negative correlation ($r = -0.72$ or $R^2 = 0.51$) between surface hardness and percentage soil moisture of the data collected from within the Phase 2 RTA study (Figure 23). Moisture values collected were 74 % of the time above was above the upper recommended range of 30 % soil moisture by Henderson *et al.* (2007). The higher soil moisture readings meant that G_{max} values were often below the recommended range (depending on soil type usage etc.) of 70 and 80 G_{max}.

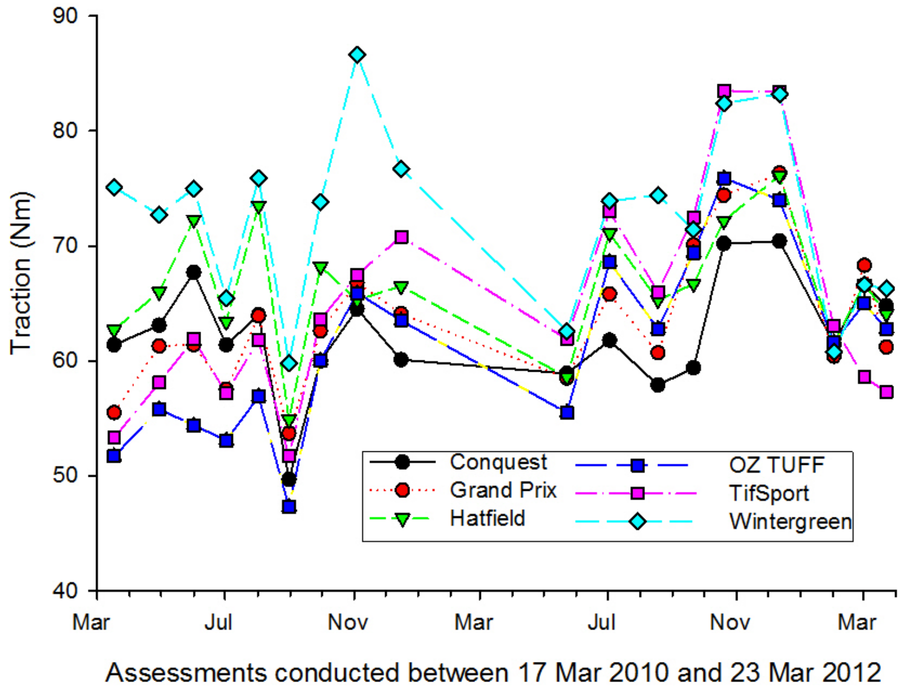
Figure 23. Correlation between soil moisture (%) and surface hardness (4th drop G_{max}) from the mean data collected within the C, D1, D2 and D6 subplots of fields 5 and 6 between 17 Mar 2010 and 23 Mar 2012. The recommended range (Henderson *et al.*, 2007) is highlighted in grey.



Traction data was collected on 18 occasions within the Phase 2 study between 17 Mar 2010 and 23 Mar 2012 (Figure 24). Following the first traction tests conducted 104 days post planting, mean traction values of OZ TUFF, TifSport, Grand Prix, Conquest and Hatfield were between 51.7 Nm and 62.7 Nm, whereas Wintergreen recorded a maximum traction value of 75.1 Nm. Throughout the course of the study Wintergreen on the most part provided the highest tractions reading compared against the other *Cynodon* spp. cultivars. The highest reading was in Nov 2010 with Wintergreen recording an impressive 87 Nm. Percentage bare ground during this timeframe of the Wintergreen cultivar averaged 1.7 %.

Traction values were consistently high over the course of the 2-year study. Only on one testing date did traction values fall below 50 Nm. On average, the mean traction figure across varieties was 65 Nm.

Figure 24. Traction (Nm) values of plots prior to any treatments being imposed (before 18 Jun 2011) and combined D1, D2 and D6 treatments within fields 5 and 6 of the RTA study. Traction data was collected on 18 occasions between 17 Mar 2010 and 23 Mar 2012.



Note: On one occasion, 23 May 2011, traction data was collected using the manual Studded Boot Apparatus. For the remainder, the Redlands Traction Tester was used.

Discussion

Across fields 5 and 6 (Phase 2) approximately 1,462 touch football games were played across each of the two fields between 27 Apr 2009 and 26 May 2011. This equated to 17 games per week and did not take into account assorted school or sports carnivals that were played at the venue.

With the exception of Conquest, all varieties produced on average an acceptable or better turf quality rating over the course of the study. Heavy and frequent rainfall events once again influenced turf quality ratings as too percentage bare ground. Spikes in high bare ground readings were as high as 40 % as observed during ratings. Mean wear observed during the Phase 2 study was 4 %. This value is well within the recommended range of having <15 % bare ground for a field to be fit for play.

Decompaction treatments once again provided mixed results when analysing the data at hand. No clear pattern was observed in the reduction of surface hardness following the immediate (weeks) application of verti-draining applications over the course of the study. Above average moisture levels (e.g. > 30 %) collected as a result or frequent rain and routine irrigation programming may be masking the benefits of the decompaction worked compared with possible outcomes if the soil profile was much drier. The varying soil type, moisture levels and usage at the RTA may be influencing what benefit and how long the benefit lasts as a result of implementing amelioration techniques.

4. The University of Queensland (UQ)

Case Study – Actual Wear

Introduction

Since 2005, the DAFFQ Redlands turf research team has been conducting simulated wear studies of warm-season turfgrasses, for use on elite and community sportsfields, at Redlands Research Facility (RRF). Over recent years questions have been asked by turf producers and sportfield managers how practical a simulated wear study is compared to a sportsfield undergoing actual play to test the strength of a turfgrass. To help answer this, one of the TU08018 project aims was to assess and compare results (e.g. wear and turf quality) of three trial sites; the RRF simulated study (refer to Chapter 2), the replicated study conducted at the Redlands Touch Association (RTA) (refer to Chapter 3) and the case study site constructed at The University of Queensland (UQ), St Lucia Campus.

In Sep 2010, discussions were held between TU08018 project leader Matt Roche and UQ Senior Supervisor Grounds, Shane Biddle about conducting a case study on a field at St Lucia Campus that was earmarked for returfing due to constant high usage and the need to fulfil user expectations. It was decided that playing field 4 would be the site to trial the large unreplicated plots containing 3 of the more promising wear tolerant varieties, chosen from collected DAFFQ data, against the green couch (*Cynodon dactylon*) variety 'Wintergreen', the old industry standard. Wintergreen was included in the study as the old industry standard, but it was also the decision of UQ management that the variety would be the sole choice of turf replacement for the playing field. Wintergreen is often a common choice by turf managers or architect's etc. primarily due to price and availability. However, the variety which was discovered by Peter McMaugh back in 1969 has sparked much debate about what is Wintergreen and does a true-to-type source exist. The problem lies with the success of Peter's original Wintergreen; however over the years, for a number of reasons, the integrity of the variety which was not registered for Plant Breeder's Rights (PBR), has diminished and numerous forms of common couch are being called and sold commercially as Wintergreen. The quality and wear tolerance, among other characteristics, vary considerably and turf managers or architect's etc. do not know what they are paying for or how the turfgrass will perform, compared with the original Wintergreen selection that did so well.

The University of Queensland was interested to see how the 3 promising wear tolerant varieties would compare against Wintergreen in terms of value for money i.e. would paying more upfront ($\$/m^2$) provide greater longevity (fewer turf replacements) of the turf surface, and which variety provides better turf quality if routine (as per Shane Biddle's recommendations) turf management practices are undertaken across the board and all varieties are treated the same.

Material and Methods

The case study site was established on playing field 4 at The University of Queensland, St Lucia Campus, St Lucia, Brisbane, Queensland (27°00'S lat, 153°29'E long, 18 masl). The establishment of the case study site tested the patience of everyone involved in the project due to the infamous Brisbane Floods. Planting was to commence 10 Jan 2011, the same week the flood waters peaked in Brisbane. Due to the devastating impact of the floods, recovery efforts and continued inclement weather, planting of the site was not achieved until 21 May 2011 (Plate 9). The astonishing achievement was made possible by the team at UQ and staff at Australian Lawn concepts, Evergreen Turf, Oz Tuff Turf, Turf Force and Twin View Turf. Their professionalism and dedication in seeing the field preparation and planting through to completion was commendable given the task at hand.

The four varieties, including 3 of green couch (*C. dactylon*) 'Grand Prix' (14 May 11), 'OZ TUFF' (28 Apr 11), 'Wintergreen' (27 Apr 11) and 1 *Cynodon* hybrid (*C. dactylon* x *C. transvaalensis*) TifSport™ (13 May 11) were planted over a 17 day period. Each variety was planted as full sod covering 1,500 m² or ¼ of the playing field (divided into field 4a and 4b) (Figure 32). Plots were unreplicated.

Information pertaining to turfgrass management of the case study site can be found within subsequent pages in a report provided by Shane Biddle, Senior Supervisor Grounds, UQ.

Informal ratings were undertaken by Matt Roche, TU08018 project leader on three separate occasions, 10 Nov 2011, 2 Mar 2012, and 9 May 2012. During the inspections subjective colour [0 (= no green) to 9 (= dark green); 6 acceptable colour], subjective turf quality [1 (= worst) to 9 (= best); 6 acceptable colour], general wear ratings and notes on turf health were taken of each variety. A comprehensive collection of digital photos were taken of the 4 varieties.

Plate 7. The January 2011 Brisbane Floods caused significant disruption to the setup and planting of the case study site at The University of Queensland, St Lucia. Photos taken of playing field 4 show (a) torrential rain the week commencing 10 Jan 2011, (b) The Brisbane River at its peak covering the playing field, (c) silt damage across the field once the water level subsided, (d) two recently planted turf varieties growing in 6 May 2011 and (d) all four turfgrass cultivars planted in situ 21 May 2011.

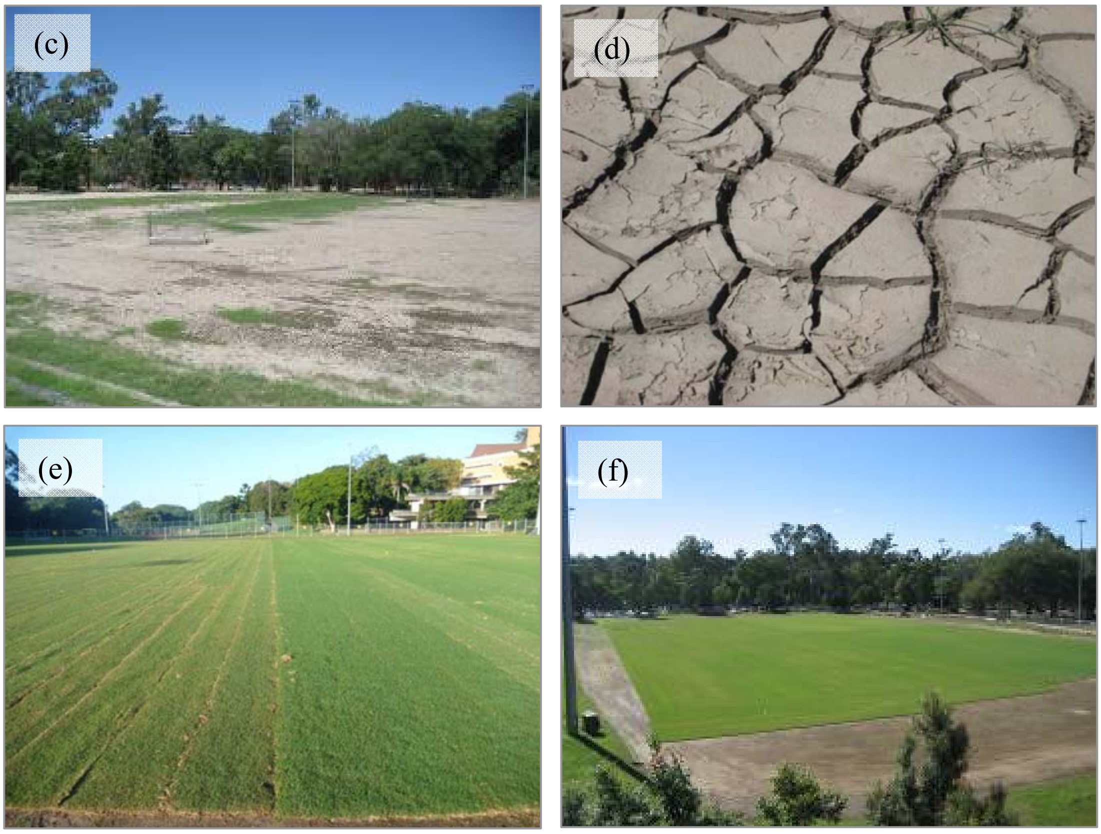
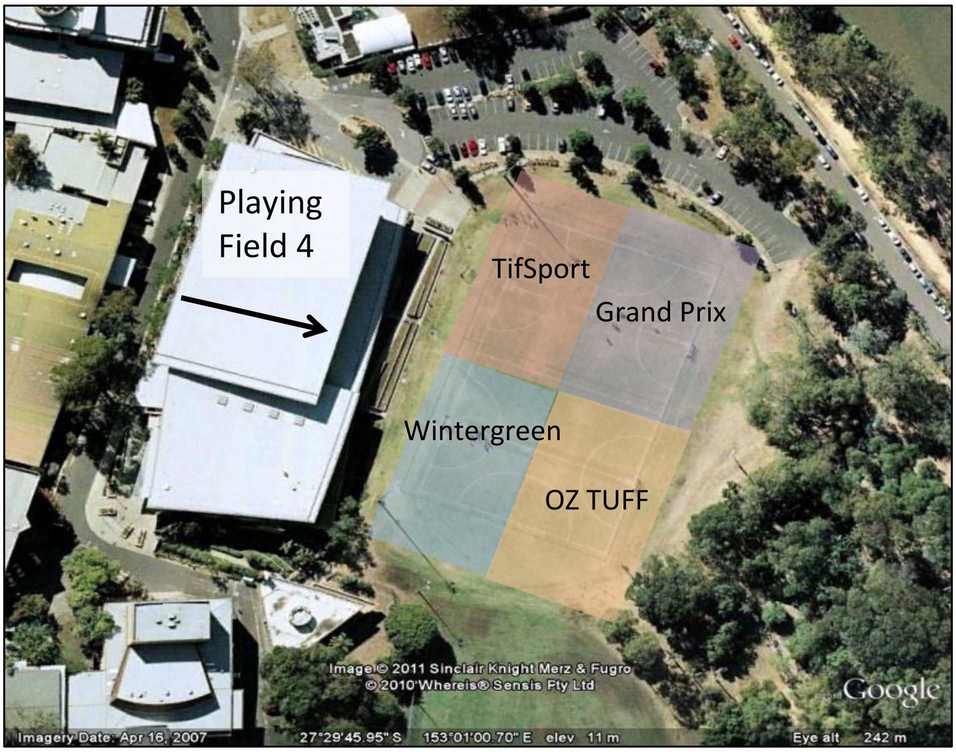


Figure 25. The layout of observational plots located on playing field 4 at The University of Queensland, St. Lucia Campus, Brisbane, Qld.



Results

The following information contains information collected by the Project Leader from the UQ Case Study site on 10 Nov 2011, 2 Mar 2012, and 9 May 2012. Content includes, subjective colour and subjective turf quality ratings, along with general wear ratings and comments of (i) Grand Prix, (ii) OZ TUFF, (iii) TifSport, and (iv) Wintergreen.

10 November 2011

(i) **Grand Prix**

- Colour rating 7, quality rating 6.5-7.
- Wear present in a small number of areas; approximately up to 5% damage is evident in one of the worst areas which is pictured below.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) wear (left) vs. no wear (right), and (d) the worst worn area of that cultivar of grass.

Plate 8(a-d). Photos taken at the UQ case study site of Grand Prix on 10 Nov 2011.

(a)

(b)

(c)

(d)

(ii) **OZ TUFF**

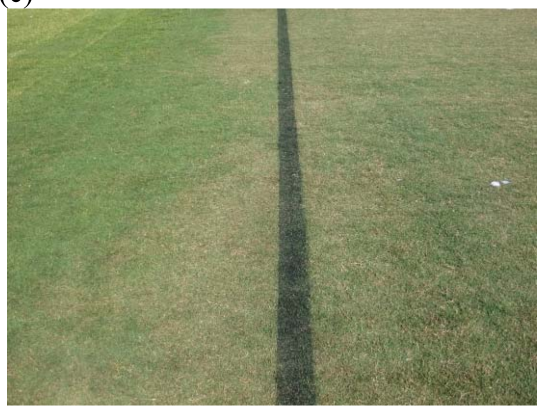
- Colour rating 7, quality rating 8.
- Little to no wear was observed.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) no wear (left) vs. wear (right), and (d) the worst worn area of that cultivar of grass. No soil is visible, only scuffing of the turf surface/thatch has occurred.

Plate 9 (a-d). Photos taken at the UQ case study site of OZ TUFF on 10 Nov 2011.

(a)

(b)

(c)



(d)

(iii) **TifSport**

- Colour rating 5.5, quality rating 7.5.
- Little to no wear was observed.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) wear (left) vs. no wear (right), and (d) the worst worn area of that cultivar of grass. No soil is visible, only scuffing of the turf surfaces/thatch has occurred.

Plate 10 (a-d). Photos taken at the UQ case study site of TifSport on 10 Nov 2011.

(a)

(b)

(c)

(d)

(iv) **Wintergreen**

- Colour rating 7.5, quality rating 6-6.5.
- This cultivar was profusely seeding. A high density of seed heads means the turf manager is going to have to mow the turfgrass, while the other three cultivars (Grand Prix, OZ TUFF and TifSport) being evaluated are producing little to no seed heads, and therefore are not needing a mow.
- Wear present in a number of areas across the field; approximately up to 40% damage is evident in one of the worst areas which is pictured below.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) no wear (left) vs. wear (right), and (d) the worst worn area of that cultivar of grass.

Plate 11 (a-d). Photos taken at the UQ case study site of Wintergreen on 10 Nov 2011.

(a)

(b)

(c)

(d)

2 March 2012

(i) **Grand Prix**

- Colour rating 7.5, quality rating 7.5.
- A blowout showing wear damage of 20 % was observed as the worst area within the Grand Prix plot. However, the remaining turf was scuffed and showed no other signs of wear.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) wear (left) vs. no wear (right), and (d) the worst worn area of that cultivar of grass.

Plate 12(a-d). Photos taken at the UQ case study site of Grand Prix on 2 Mar 2012.

(a)

(b)

(c)

(d)

(ii) **OZ TUFF**

- Colour rating 8.5, quality rating 8.
- No wear was evident, only scuffing of the turf surface was visible.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) no wear (left) vs. wear (right) and (d) the worst worn area of that cultivar of grass.

Plate 13(a-d). Photos taken at the UQ case study site of OZ TUFF on 2 Mar 2012.

(a)

(b)

(c)

(d)

(iii) **TifSport**

- Colour rating 8, quality rating 7.
- Wear present in a small number of areas; approximately up to 2 % damage is evident in the worst area shown below. The photo was taken in front of a hockey goal. The remaining turf showed only scuffed areas of turf, not worn areas or blowouts.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) wear (left) vs. no wear (right) and (d) the worst worn area of that cultivar of grass.

Plate 14(a-d). Photos taken at the UQ case study site of TifSport on 2 Mar 2012.

(a)

(b)

(c)

(d)

(iv) **Wintergreen**

- Colour rating 8.5, quality rating 7.
- No worn areas of turf were visible, only scuffing of the turf surface at worst.
- Images below contain a (a) field shot of the turf cultivar, (b) a general turf photo, (c) mo wear (left) vs. wear right and (d) the worst worn area of that cultivar of grass.

Plate 15(a-d). Photos taken at the UQ case study site of Wintergreen on 2 Mar 2012.

(a)

(b)

(c)

(d)

9 May 2012

(i) **Grand Prix**

- Colour rating 5 and quality rating 5.5 of worn turf area.
- Colour rating 7 and quality rating 7 of predominantly unworn turf area.
- Wear present in a small number of areas; approximately up to 40 % damage is evident in one of the worst areas which is shown below.
- Images below contain (a) a field shot of the turf cultivar, (b) a general turf photo, (c) an unworn area and (d) the worst worn area shown of Grand Prix on the day.

Plate 16(a-d). Photos taken at the UQ case study site of Grand Prix on 9 May 2012.

(a)

(b)

(c)

(d)

(ii) **OZ TUFF**

- Colour rating 4.5 and quality rating 5 of worn turf area.
- Colour rating 7.5 and quality rating 6 of predominantly unworn turf area.
- Wear present across the majority of the plot due to a high number of hockey games/training/unscheduled use. Up to 4 % damage is evident in one of the worst areas which is shown below.
- Images below contain (a) a field shot of the turf cultivar, (b) a general turf photo, (c) an unworn area and (d) the worst worn area shown of OZ TUFF on the day.

Plate 17(a-d). Photos taken at the UQ case study site of OZ TUFF on 9 May 2012.

(a)

(b)

(c)

(d)

(iii) **TifSport**

- Colour rating 5 and quality rating 5.5 of worn turf area.
- Colour rating 6.5 and quality rating 7 of predominantly unworn turf area.
- Wear present in a small number of areas; approximately up to 35 % damage is evident in one of the worst areas which is shown below.
- Images below contain (a) a field shot of the turf cultivar, (b) a general turf photo, (c) an unworn area and (d) the worst worn area shown of TifSport on the day.

Plate 18(a-d). Photos taken at the UQ case study site of TifSport on 9 May 2012.

(a)

(b)

(c)

(d)

(iv) **Wintergreen**

- Colour rating 3.5 and quality rating 4.5 of worn turf area.
- Colour rating 7.5 and quality rating 7 of predominantly unworn turf area.
- Wear present across the majority of the plot due to a high number of hockey games/training/unscheduled use. Up to 3 % damage is evident in one of the worst areas which is shown below.
- Images below contain (a) a field shot of the turf cultivar, (b) a general turf photo, (c) an unworn area and (d) the worst worn area shown of Wintergreen on the day.

Plate 19(a-d). Photos taken at the UQ case study site of Wintergreen on 9 May 2012.

(a)

(b)

(c)

(d)

During inspections conducted by DAFFQ staff wear ratings were taken from within each of the four plots identifying the worst worn area of each variety (Table 12). Average percentage wear varies considerably between the four green couch (*Cynodon* spp.) varieties (1-22 %), but at the same time it is misleading to compare the values. This is because the case study was not designed to accommodate replications, nor was it possible for wear, through actual game play (e.g. hockey, touch football, soccer), to be applied evenly across all four varieties.

Table 12. Summary of wear values (%) within the worst (e.g. blowouts) areas of the four turf varieties trialled as noted during observations made on 10 Nov 2011, 2 Mar and 9 May 2012.

	Date of inspection			
	10 Nov 2012	**2 Mar 12**	**9 May 12**	**Average**
Grand Prix	5 %	20 %	40 %	22 %
OZ TUFF	0 %	0 %	4 %	1 %
TifSport	0 %	2 %	35 %	12 %
Wintergreen	40 %	0 %	3 %	14 %

17 May 2012

THE UNIVERSITY OF QUEENSLAND
AUSTRALIA

Case Study Report by Shane Biddle, Senior Supervisor Ground, UQ

The four turf varieties 'Grand Prix', 'OZ TUFF', 'TifSport' and Wintergreen' for the case study was finally laid 18 May 2011. A combination of weather and existing profile kept delaying the project. The field was originally built on top of a car park which became a building site with the construction of the adjacent UQ centre. After the initial rotary hoe we introduced sand and organics to provide a better growing media and enable the field to be shaped better for drainage. Four weeks later the turf was top dressed lightly to fill any gaps between to rolls and fertilised. As we moved through the winter months we did not see a lot of growth. We applied foliar's to help strengthen the leaf and promote root growth. The field was opened for play in the second week of August 2011.

As we anticipated the expectation and booking requests for the field was high. There was no lead in time prior to the filed being open for play:

- Monday – Touch football between 1800 – 2200 hrs
- Tuesday - Soccer training between 1800 – 2100 hrs
- Wednesday – Touch football between 1800 – 2200 hrs
- Thursday – Hockey training between 1730 – 2100 hrs
- Friday – social bookings from 2 – 4 hours (ad hoc)
- Saturday - social bookings from 2 – 4 hours (ad hoc)
- Sunday – social bookings from 2 – 4 hours (ad hoc)

The wear on all 4 species started to show after 4 weeks following the opening of the field. The wear concentration was in the expected middle thirds of the touch fields (east-west) and the middle third of the soccer field (north-south). The wear patterns showed considerable leaf loss and minor damage to the turf surface following concurrent weekends of inter college (UQ) touch competitions being held. There was and continues to be added damage to the turf surface from illegal play i.e. using the field for fixture or recreational use without a booking. The latter issue was exacerbated following the continued inclement weather experienced. In October 2011, we observed the worn areas remaining in situ, though recovery was forthcoming from 3 of the 4 varieties of couch; TifSport didn't show signs of recovery until November.

The soccer and hockey seasons finished in mid-October and the Touch Comp continued until mid-December 2011. By December, only touch football play was remaining 2 nights per week and some social bookings. At this point in time all four varieties were showing signs of recovery while still being in play.

We carried out a renovation activities in the last week of December 2011 with a light scarify, Verti-Drain, fertilise and top dress. A light scarify program was adopted in anticipation for the high usage requirements that were to commence in late-January 2012 and continue until later the same year (i.e. December). The usage for the 2012 season is as follows:

- Monday – Touch football between 1800 – 2200 hrs
- Tuesday - Soccer training between 1800 – 2100 hrs
- Wednesday – Touch football between 1800 – 2200 hrs
- Thursday – Hockey training between 1700 – 2100 hrs
- Friday – Soccer fixtures between 1800 – 2200 hrs
- Saturday – Soccer fixtures/social bookings between 1200 – 1600 hrs
- Sunday – Soccer fixtures/social bookings between 1200 – 1600 hrs
- College training Monday to Friday 0700 – 0930 (hockey, soccer, touch, rugby)
- UQ Sport Human Movement group activities 1-2 hrs per day (ad hoc)
- Inter college touch competition which runs for 4 weekends over a Saturday and Sunday between 0800 – 1800 hrs
- Corporate games 2 days over a Saturday and Sunday between 0700 – 1800 hrs
- Illegal play - data from a 4 week security trial found that up to 2 hrs per day the field was used illegally. A group of 60 was the largest group witnessed on the field.

Since the opening of the field the nutrition program has been the same that is delivered across all 8 sports fields (14 hectares) at the St Lucia campus. Following annual soil testing, applicable amendments are carried out in late August with granular fertiliser being applied 4 times per year as well as a foliar schedule which is monthly. The field is routinely verti-drained every 8 weeks to relieve compaction and improve root development etc.

The species selected for the trial have all reacted in different ways to the conditions at UQ. As expected they all had wear issues due to the overuse of booked sport and the problematic illegal play. They did however all recover well and we had a great surface for the start of 2012. I have provided some information on all species on how they have performed during the case study at UQ. This includes:

TifSport - Very good colour during growing season and has ok colour heading into winter. It was the first to show signs of wear and slow in recovery until warmer temperatures arrived. It had a one disease issues with pythium (*Pythium* spp.) during the wet spell in January 2012.

Wintergreen - Very good colour during growing season and has good colour heading into winter. It has good wearability and has very good recovery. It had no disease issues during the wet spells.

Grand Prix - Excellent colour during growing season and ok to good colour heading into winter. It has good wearability and good recovery but is not as aggressive as the other species. It had one disease issue with pythium during January's wet period.

OZ TUFF - Excellent colour during growing season and OK to good colour heading into winter. It has good wearability and good recovery. The variety had one disease issue with pythium during the wet spell in January.

The four turf species have shown similar characteristics throughout the study and all grasses have had huge amounts of sport played on them. All four grasses have suffered various levels or wear damages at different stages throughout the observation period, but have all recovered to meet current usage requirements.

UQ has enjoyed being part of the DAFFQ study. It has provided us with an opportunity to see how some of the more wear tolerant grasses perform adjacent to the old industry standard Wintergreen. The case study site has sparked much interest from industry members and has seen many visitors come to inspect the field. We look forward to seeing how the grasses perform in 2012 and will be sure to keep DAFFQ researchers and members of the Sports Turf Association QLD (STA QLD) up to speed with developments.

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Discussion

Twelve months post establishment of the UQ case study site it is very difficult to determine a clear winner out of all 4 varieties. Following the delays in planting and continued inclement weather the playing field was not open for play until the second week of August 2011. It was hoped that the field would have been opened earlier to allow access to the students and registered sport, but this was not achievable. The latter would have resulted in extra wear and compaction across the turf varieties possibly resulting in aesthetic and performance differences of the grasses. However, as a result of reduced bookings due to the late start and sound maintenance activities, the playing field was kept in good repair up until the completion of the formal observation period by DAFFQ staff.

At various stages throughout the twelve month observational period each variety of turf portrayed different characteristics; some good and some unwanted. For example during the field inspection conducted on 10 Nov 2011 Wintergreen was observed as having a higher number of seedheads present across the entire plot (seeding profusely). This can be problematic due to higher maintenance requirements needed to remove (mow) unsightly seedheads or because of the interference of the seed and inflorescence with playability of ball sports across the surface. At times, the same cultivar varied in performance by having up to 40% wear in particular areas (blowouts), whereas other times zero wear was evident. Wintergreen also maintained a darked green colour going into winter.

At other time during inspections Grand Prix, TifSport, and OZ TUFF all produced mixed results in terms of wear tolerance. In the worst (blown out areas) Grand Prix had 5-40 % wear, while TifSport had 0-35 % wear and OZ TUFF had 0-4% wear. However, it is difficult to compare these figures against one another because they were not replicated and wear was applied evenly across all cultivars e.g. not every field (4a and 4b) was in use, nor is it possible to impose the same amount of wear evenly across all areas of the turf.

It was interesting that high wear was observed across the majority of the turfgrasses during inspection on 9 May 12. From discussions between Shane Biddle and Matt Roche it was noted that the wear was brought about from scheduled and illegal play across the fields during inclement weather. Although field closures, short or long term, can be seen as a bad decision by many, at times it is necessary to maintain safety and provide longevity to the turf surface for future games to be played.

Throughout the study several persons from within the turf industry made comment about the setup of the case study and questioned why the plots were not replicated. However, the aim of this case study was to assess how the varieties of turf perform under UQ's turf management program and how they individually responded to wear and tear. For comparative purposes, this was the purpose for having established the simulated wear facility at Redlands Research Facility (refer to chapter 2) and the larger replicated test place under actual wear at the Redlands Touch Association (refer to chapter 3).

DAFFQ researchers will continue to work with Shane Biddle, Senior Supervisor Ground at UQ over the next seven months to see how the grasses perform over the 2012 calendar year. A special report will be made available to the leading Australian sports turf magazines at the years end.

Technology Transfer

Seminars and Presentations

Conducted throughout the course of the study:

- PowerPoint presentation on project outcomes to date at the QLD Forum and Mini Field Day, **Caboolture**, 12 May 2011. The day was jointly organised by Turf Australia and Sports Turf Association Queensland, Inc. (STA QLD).
- Turf Seminar and Trade Expo, Paterson's Stadium, Subiaco, **Perth**, 13 Jul 2011 – Traffic Tolerance of Warm-Season Turf Grasses under Community Sports Field Conditions (Matt Roche - Invited Speaker).
- Centre for Urban Greenery and Ecology (CUGE) 3rd Regional Turf Seminar, Enhancing Tropical Turfgrass and Soil for Better Performing Amenity and Sports Surfaces, Fort Canning Centre – Gallery, **Singapore**, 21 to 22 Jul 2011 – Research on Traffic Tolerance of Turfgrass Species (Matt Roche - Invited Keynote Speaker).
- 'Show me the green stuff', Panel discussion by DAFFQ members Jon Penberthy and Cynthia Carson to forum hosted by Parks and Leisure Australia and Redland City Council, Redlands Showgrounds, **Cleveland**, 26 Oct 2011.
- 23 Nov 2011 a project update was given by Jon Penberthy, DAFFQ Turf Experimentalist to attendees of the Turf Grass Association of Australia (TGAA) Victoria's seminar and trade day held at Wesley College's Glen Waverley Campus, **Victoria**.
- Project update provided by Project Leader at The National Turf Validation Meeting 2011, Byron Bay Golf Club, **Byron Bay**, 13 Dec 2011.

Presentations already scheduled following the completion of the study to present on project findings:

- Parks and Leisure Australia (PLA), Sports Turf Planning and Maintenance Workshop, Tony Ireland Stadium, **Townsville**, 20 Jun 2012.
- Sports Turf Association QLD (STA QLD) Workshop, Tony Ireland Stadium, **Townsville**, 21 Jun 2012.
- Sports Turf Association QLD (STA QLD) Field Day, Redlands Research Facility, Cleveland, **Brisbane**, 18 Jul 2012.
- Sports Turf Association NSW (STA NSW) Regional Seminar, Sports Turf Renovation Practices, Kurri Kurri TAFE, **Sydney**, 14 Aug 2012.

Publications

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Industry Visits

With trials being established at Redlands Research Facility (simulated wear, mowing frequency and growth regulator studies), Redlands Touch Association (actual wear) and University of Queensland (case study under actual wear) industry has had significant opportunity to inspect the progress of the trials throughout the duration of the study. As for the Redlands Research Facility the following visits have taken place to inspect the trials:

The Redlands trials were inspected by Dr Bill Anderson, University of Georgia, USA, 17 Mar 2010; The Honorable Minister Tim Mulherin (Minister for Agriculture, Food and Regional Economies), State Member for Capalaba Michael Choi and members of the Centre for Lifestyle Horticulture (CLH) visited Redlands trials, 6 Jul 2011; TAFE students from Moreton Institute of TAFE, 10 Aug 2011; turf industry members from Darwin, 10 Aug 2011; Mr Macallum a sportsfield constructor who wanted to choose a turf for 6 new sportsfields in Gosford, NSW, 11 Aug 2011; Brett Morris from The Brisbane Golf Club, 19 Sep 2011; Wendy Weir and Stewart from Brisbane Airport Corporation (BAC), 3 Oct 2011; Turf Industry Advisory Committee, 11 Nov 2011; Warren Braybon and Peter Howat from Turf Culture, 15 Dec 2011; and a turf producer from the UK who was shown around by Matt Holmes, IDM Turf Australia, 6 Jan 2012; Mark Walker from Sygenta, 18 Jan 2012; Mark Stidwill, PGG Wrightsons Turf and Tim Bowyer, Patten Seed Company, USA, 7 Feb 2012; Peter Newton of Bay Turf, 16 Feb 2012; Bill Morrow, OZ Tuff Turf, 5 Apr 2012; Mark Godfrey, Director of Sports Turf Research Institute (STRI) Global, UK, 13 Apr 2012; Turf Industry Advisory Committee, 17 Apr 2012; and Richard Hayden, Director of Operations, (STRI) Global, UK, 7 May 2012.

Media

- Williams, K. 2009. Is the grass greener at Redlands Community Sports Fields? Qld Dept of Primary Industries & Fisheries Intranet (8 January 2009).
- The grass is greener, Bayside Bulletin, 13/01/09, General News, p 4.
- Hardiness test for filed grass, Wynnum Herald, 14/01/09, General News, p 22.
- Grass Study in a field of its own, Australian Horticulture, February 2009, p 5.
- Roche, M.B. 2010. Study documents turf wear. The Redland Times, Friday May 28, p. 11 (Appendix).
- Tough turf put to the test, *My Sunshine Coast*, General News, 1/12/2010.
- Radio interview by Project Leader Matt Roche with ABC Southern Queensland (Toowoomba) on 2/12/2010 – 10:22 AM (Appendix).
- Tough turf put to the test, *Bayside Bulletin*, 14/12/2010, General News, Page 50 (Appendix).
- Tough turf put to the test, Turf Australia Industry Newsletter, Feb. 2011 p. 29.
- Radio interview by Project Leader Matt Roche with Radio 4GR Toowoomba on 22/02/2011 – 11:50 AM (Appendix).
- DAFFQ Lifestyle Horticulture direct e-newsletter, 4 May 2011 which was sent to 1,736 subscribers,
- (http://www.vision6.com.au/em/message/email/view.php?id=771439&u=13082).
- DAFFQ Lifestyle Horticulture direct e-newsletter, 7 December 2011 which was sent to 1,706 subscribers,
- (http://www.vision6.com.au/em/message/email/view.php?id=816225&u=13082).
- DAFFQ web site: http://www.dpi.qld.gov.au/26_15272.htm (accessed 14 May 2012).
- Throughout the study images and videos acquired were from time to time added to flickr®. The research team first used flickr® to disseminate project information in March 2011. To date, over 2,300 times the Redlands Turf Research photo collection has been viewed. The photos can be accessed at http://www.flickr.com/photos/redlandsturfresearch/collections/72157626950858707/ (accessed 14 May 2012) or Google 'Redlands Turf Research'.
- Milestone updates were also routinely added to the following web sites to keep members of the turf industry up to date on the work being undertaken. The sites included: Sports Turf Association NSW (STA NSW) www.sportsturf.asn.au; Sports Turf Association VIC (STA VIC), www.tgaa.asn.au; and Australian Golf Course Superintendents Association (AGCSA), www.agcsa.com.au.

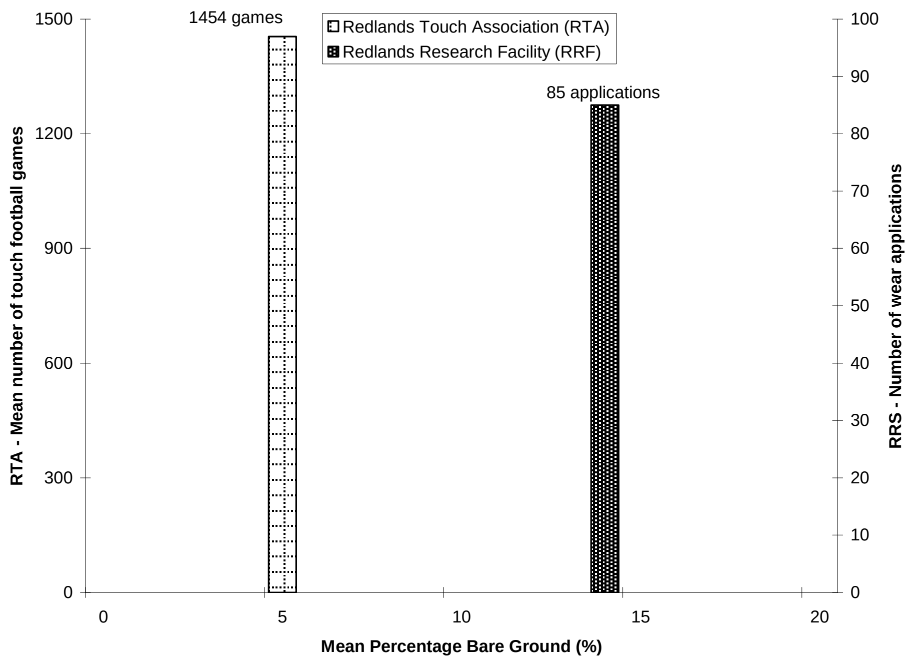
General Project Conclusion and Recommendations

Wear tolerance

Initially the present study was to run for a period of 2 years. To obtain meaningful wear tolerance information it was important that the trial be extended to capture a minimum of 2 years of replicated data at both RTA trial sites (Phase 1 and 2) undergoing actual wear through playing touch football games. The extended timeframe also provided researchers to collect 3 years, or the equivalent of 4 touch football seasons, worth of data from the RRF simulated wear study.

By collecting a minimum of 2 years data from both the RRF and RTA sites it allowed researchers to assess and compare wear between the two sites. Throughout the duration of the study, 2009 to 2012, a total of 85 wear applications were applied to the RRF site using the Redlands Traffic Wear Simulator; whereas the RTA played on average of 1,454 games per field over a 2-year period (either 09/10 or 11/12) (Figure 26). Following 85 simulated wear applications, on average 25.4 % of bare ground was observed. The collated figures from Phase 1 and Phase 2 of the RTA trial showed on average only 4.9 % bare ground. This is well under the unacceptable level of 15 % recommended by McAuliffe and Roche (2009) for safe play.

Figure 26. Comparison of turf damage (% bare ground) between simulated wear imposed at RRF and actual wear from touch football games at RTA. Mean values are shown.



Notes: RTA Phase 1 saw 1,445 games (Table 6) and Phase 2 saw 1,462 games (Table 9). RRF saw 85 wear applications (Table 1).

When comparing wear (percentage bare ground) data from RRF to that of the RTA of the green couch cultivars only, it shows that 1 pass of the Redlands Traffic Wear Simulator roughly equates to 50 touch football games. There is a significant difference between the two values; however it is relative and the values now provide researchers with a better understanding how the simulated machine compares to the damage incurred by actual touch football games across a range of warm-season turfgrasses.

Questions may be asked as to why the simulated wear (number of applications) was so high compared with the actual play at the RTA, and why wasn't simulated applications backed off in an attempt to complement each other? The questions are valid; however, little information will be derived from such a result. The present study, in particular the work conducted at the RRF and RTA trial sites, will provide turf managers with information on what turf species and or cultivar has a greater wear tolerance and or recovery than other commercially available varieties. Such information will provide beneficial particularly when sport participation and field user requirements are increasing because of lifestyle options and growing urbanisation.

As seen within the RTA and UQ trial sites, turf damage from scheduled and illegal play across the fields during inclement weather is a major problem and warrants further investigation by both facilities. This would include detailing the extent of damage and recovery times, but also looking to implement a rudimentary field closure program. The purpose behind implementing a field closure is to protect the performance of the playing surface not just for the current season, but for the life of the field. Obviously sports clubs don't wish to have their field close for any reason. A large majority of clubs are daunted about having to introduce or follow guidelines associated with a field closure program. However, due to ill-fated sportsfield designs and/or construction techniques, limited resources, poor turfgrass selection and/or cover, inadequate and/or no drainage, overuse etc., the practice if well-conceived is essential in providing longevity of the playing surface.

Variation in wear tolerance and recovery between species of turf trialled within the present study were very large. The RRF simulated study showed wear tolerance varied by as much as 35 % between species when wear was greater than 15 % over the course of the study. Kikuyu was the worst performing turf species because of its inability to recover in this instance. Blue couch varieties ranked 2 out of 3, because of their ability to recover following high wear. The best performing species was the green couch varieties. However, variation within the species was significant and the same was observed within the RTA studies too.

It was impossible to have wear applied evenly to all subplots within the RTA studies undergoing actual wear through the playing of touch football games. However, having two phases, effectively 8 blocks/replications, of data being collected provided researchers with sound information on how much damage a touch football field incurs and what the likely timeframe is for recovery during a football season. The RTA wear trials also provided members of the industry the opportunity to see how wear trials perform in a 'real environment' on a larger scale. Subplots within the RRF site were 3 m^2, the RTA subplots were 13.2 m^2. The next step was to go bigger and establish a case study site at UQ. Each plot within the UQ site was 1,500 m^2, however researchers were limited by available land and consequently only 4 varieties were trialled. DAFFQ researchers believe the present study provided an excellent opportunity, the first of its kind, to test and observe wear tolerance of commercially available sportsfield grasses in the 3 trial locations (RRF, RTA and UQ).

Future (simulated) wear trials are warranted across new and improved turfgrasses that are or will soon be commercially available for potential sportsfield applications. Newly developed grasses, many of which are Australian bred, look to provide improved traits e.g. shade tolerance, greater rhizome density, drought tolerance etc. Research should not cease just because some of the grasses within the present study have demonstrated moderate to great results. Striving to identify a turfgrass that can provide more with less will no doubt help community sportsfields and continued sport participation.

For turf managers, having a playing field that possesses little to no wear damage will in turn lower maintenance and operational requirements throughout the often relentless fixtures scheduled for each calendar year. Turf renovations, small or large can be costly and time consuming, particularly if the field has to be closed for any given period for the turf to root down and provide a consistent playing surface. This is why community sports clubs should seek independent information on turfgrass performance and maintenance and make an informed choice, not primarily based on cost and marketing alike is done all too often. The choice should be made to meet the clubs user requirements and expectations. Doing so will provide long-term gains to the clubs asset (the field) and protect the future of sport participation at the grass roots level.

Decompaction

Usage (legal or illegal play) and machinery traffic are the prime cause of soil compaction and subsequent surface hardness. This is more pronounced on sandy loam to clay soils as commonly seen in community based sportsfields, and is particularly a problem if they are highly moist or saturated at the time of traffic.

Research by Henderson *et al.* (2007) recommended that surface hardness (Clegg hammer) readings of community sportsfields should be between 70 and 80 G_{max} across sandy loam to clay soils. To achieve this they also recommended that soil moisture levels be between 15 and 30 %. However, their research was undertaken during a dry period of El Niño. Throughout the course of the present study, the La Niña climate pattern has been in full swing making it difficult to control moisture and surface hardness levels within sandy loam to clay soils, like that of the RTA.

Moisture levels however did play a significant role in influencing surface hardness. There was a moderate negative correlation ($r = -0.42$ or $R^2 = 0.17$) observed between surface hardness and percentage soil moisture of the RRF simulated wear study; also, there was a strong to high negative correlation (Phase 1: $r = -0.86$ or $R^2 = 0.74$; Phase 2: $r = -0.72$ or $R^2 = 0.51$) between surface hardness and percentage soil moisture of the RTA trail sites i.e. the negative correlation indicates that as soil moisture increased, surface hardness decreased, and vice–versa.

Verti-draining of the RRF and RTA trial sites was undertaken collectively on 43 occasions between 2009 and 2012. No clear pattern in surface hardness reduction was observed over the four years as a result of incorporating decompaction treatments (D1, D2 and D6) across any of the trial sites. For example, following decompaction work, surface hardness did not always reduce; nor within the RRF study, did 6-weekly (D6) decompaction treatments regularly provide lower surface hardness values (G_{max}) than not undertaking any decompaction work. The variation could be a result of soil moisture, usage (touch football games or simulated wear) and soil type.

The benefits of undertaking decompaction work to improve the soil properties and increase turf health (e.g. root development) are well known. However, further research is warranted to determine the effectiveness of decompaction treatments across a range of soil types and moisture levels undergoing wear. Latter combinations may be providing limited benefit of decompaction because of the changing parameters such as high soil moisture and increased usage resulting in compaction. Such work will provide turf managers with a better understanding of how long decompaction treatments are providing tangible benefits in reducing surface hardness before further amelioration work is required.

Plant Growth Regulators

The present study undertook assessment trialling varied rates of trinexapac-ethyl (active constituent 120g/L) across 19 medium- to coarse-textured grasses suitable for sportsfield use. Mowing requirements were assessed of the latter blue couch, green couch and kikuyu varieties over a twelve month period trialling trinexapac-ethyl at varied rates.

The findings showed that turf managers have the ability to save time and resources by using growth regulators as per the recommended label to reduce the need for mowing. A mowing reduction of 15 to 29 % could be made across the majority of the turfgrasses trialled. However, fast (vertical) growing turfgrasses like kikuyu showed no benefit of having even the highest trinexapac-ethyl application rate (2.0 L/ha) applied. This is why recommendations are in place by Sygenta (i.e. Primo Maxx® label) that an application rate between 1.65 and 4.15 L/ha be applied.

The Primo Maxx® (trinexapac-ethyl) label produced by Sygenta® lists recommend rates for 5 species and specifically 4 cultivars (‘Common’, ‘Greenless Park’, ‘Santa Ana’ and ‘wintergreen’) of turf which happen to be all *Cynodon* spp. As phytotoxic data was not collected, though discernible (phytotoxic) damage and stunting was observed, further studies are warranted to determine safe application rates for a greater number of warm-season turfgrasses. Given mowing costs (including labour, fuel etc.) could be reduced by nearly 30 % the potential savings for turf maintenance budgets and clubs alike would be high. Industry adoption to use trinexapac-ethyl would be dependent on Sygenta or other chemical companies to invest in further studies to provide recommended rates across a wider range of warm-season turfgrass cultivars.

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Appendix

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NEWS

Study documents turf wear

A SCIENTIFIC research project based in the Redlands is aiming to help provide better grassed playing surfaces for local sporting groups.

The project was highlighted recently when controversy surrounded the state of the Redlands Touch Football Association's playing fields after they were damaged in wet weather by the 10th annual Cleveland Autospectacular.

Research figures released by the Queensland Department of Employment, Education, Development and Innovation (DEEDI) showed there was more to the playing surfaces than met the eye.

As part of a two-year scientific study funded by Horticulture Australia Limited and the Redland City Council, two trial sites have been established at both the touch association's grounds and the Redlands Research Station.

The aim of the study is to document the ongoing effects of turfgrass wear and soil compaction in a simulated environment as well as under actual playing conditions.

DEEDI researchers so far have been able to identify that particular grasses normally used for sport and recreational purposes can vary as much as 87 per cent in their wear tolerance.

STUDY UNDER WAY: An aerial view of trial plots at the Redlands Research Station shows the wear tolerance of grasses for community sports field conditions

Senior research scientist Matt Roche said choosing the appropriate turf cultivar would result in minimal field closures due to poor turf coverage.

"If a less suitable type of grass is chosen, the decision may mean the field could be closed for up to 85 per cent of the time because it is unfit for play," he said.

"Such a result would not only influence the sporting club's ability to make an income, but also the health and well-being of social players."

Mr Roche said he applauded the tireless efforts undertaken by the touch association groundsman Darryl Hoffman and council turf services officer Laurence Blacka for providing the local community with a safe, playable sports surface.

Mr Roche said the scientific study would be completed in November and the findings, which would be released soon after by DEEDI researchers, were expected to benefit all sporting and community groups who used natural turf playing surfaces.

Radio interview by Project Leader Matt Roche with ABC Southern Queensland (Toowoomba) on 2/12/2010 – 10:22 AM.

MEDIA MONITORS

Broadcast NewsAlert

Kristal Hargraves - Department of Employment and Economic Development

ABC Southern Queensland (Toowoomba)
Mornings - 02/12/2010 - 10:22 AM
Belinda Sanders
Producer Ms Vicki Thompson 07 4639 2878

Audience	
Male 16+:	1,500
Female 16+:	1,200
All People:	2,700

Place an Order

Sanders discuses a new kind of turf that has been developed with Matt Roche, Agri Science Queensland Scientist, Department of Employment Economic Development and Innovation, says they have studied 10 types of turf grass, some Green Couch and some Blue. Roche says turf is important for different sports. He says they look at it from a condition point of view but also a safety aspect, as sports are played on them. Roche says they will continue researching at Redlands Research Station and also other grounds. He says DEEDI are looking into the issues with grasses.

Interviewees: Matt Roche, Agri Science Queensland Scientist, Department of Employment Economic Development and Innovation
Duration: 4:20
Summary ID: W00041618672

Tough turf put to the test, *Bayside Bulletin*, 14/12/2010, General News, Page 50.

Tough turf put to the test

NEW turf research could provide answers for sporting clubs faced with having to close their playing fields due to poor turf condition.

Agri-Science Queensland scientist from the Department of Employment, Economic Development and Innovation (DEEDI) Matt Roche said a two-year study had investigated the ongoing effects of wear and tear and soil compaction on warm-season turf grass used on sporting fields, with couch varieties coming out on top.

"The aim of this project is to help community sporting groups make informed choices on the performance of natural turf surfaces to help them decide on the right turf for their communities' needs," he said.

"We've found that grasses typically used for sport and recreational purposes can vary by as much as 83 per cent in their 'wear tolerance'.

"Choosing the wrong grass could potentially see a field closed for up to 52 percent of the usual playing time, due to the surface being unfit for play."

"As well as preventing people from using the field for sport or other healthy activities, the closure could be devastating for a local community as it affects a sporting club's ability to earn income."

Mr Roche said local sporting fields often received much heavier use than fields at elite venues, as well as lacking the resources and groundskeepers with top-of-the range equipment to keep them perfectly manicured.

MATT Roche with the DEEDI Redlands Wear Simulator at trial plots at Redlands Research Station showing the wear tolerance of grasses for community sports field conditions.

"Over the course of our study, co-funded by DEEDI and Horticulture Australia Limited, we have examined the wear tolerance and durability of turf in a simulated environment at Redlands Research Station, as well as under actual playing conditions at a local touch football club.

"Three species of warm-season turf grass, including green couch, kikuyu and blue couch, encompassing 10 varieties of each, were tested for wear tolerance.

"We found that four green couch varieties produced on average between three and 18 per cent bare ground over the course of the study.

"These are good levels of wear tolerance, with anything less than 15 per cent considered acceptable for play."

Mr Roche said, in contrast, the blue couch turf grasses produced up to 98 per cent bare ground, but it recovered reasonably well.

"When choosing a turf for a sporting field or recreational area, the decision is often made on the price of the turf alone.

"However, a more expensive turf with favourable traits such as good wear tolerance and the ability to recover after high usage will often last much longer, meaning fewer management issues and turf replacement, and ultimately saving clubs money in the long run."

DEEDI acknowledges the support of Redland City Council, Redlands Touch Association and other local organisations, clubs and businesses that assisted with the trials.

Radio interview by Project Leader Matt Roche with Radio 4GR Toowoomba on 22/02/2011 – 11:50 AM

MEDIA MONITORS

Broadcast NewsAlert

Kristal Hargraves - Department of Employment and Economic Development

4GR (Toowoomba)
Focus on the Downs - 22/02/2011 - 11:50 AM
Graham Healy
Producer Ms Sonya White 07 4632 3333

Audience	
Male 16+:	3,200
Female 16+:	2,800
All People:	6,000

Place an Order

Interview with Agri-Science **Queensland** Senior Scientist, Matt Roche, who speaks of rebuilding sporting grounds post flooding. Roche says given fields and soil has sustained such inundation they can pose health risks to people as it is unknown what concentrations of contaminants the grounds are harbouring. Roche notes that much turf will need to be replaced but high temperatures of late and minor rainfalls can aid to flush out contaminants.

Interviewees: Matt Roche, Agri-Science **Queensland**
Duration: 3:22
Summary ID: W00042616806

This program or part thereof is syndicated to 1 station/s.