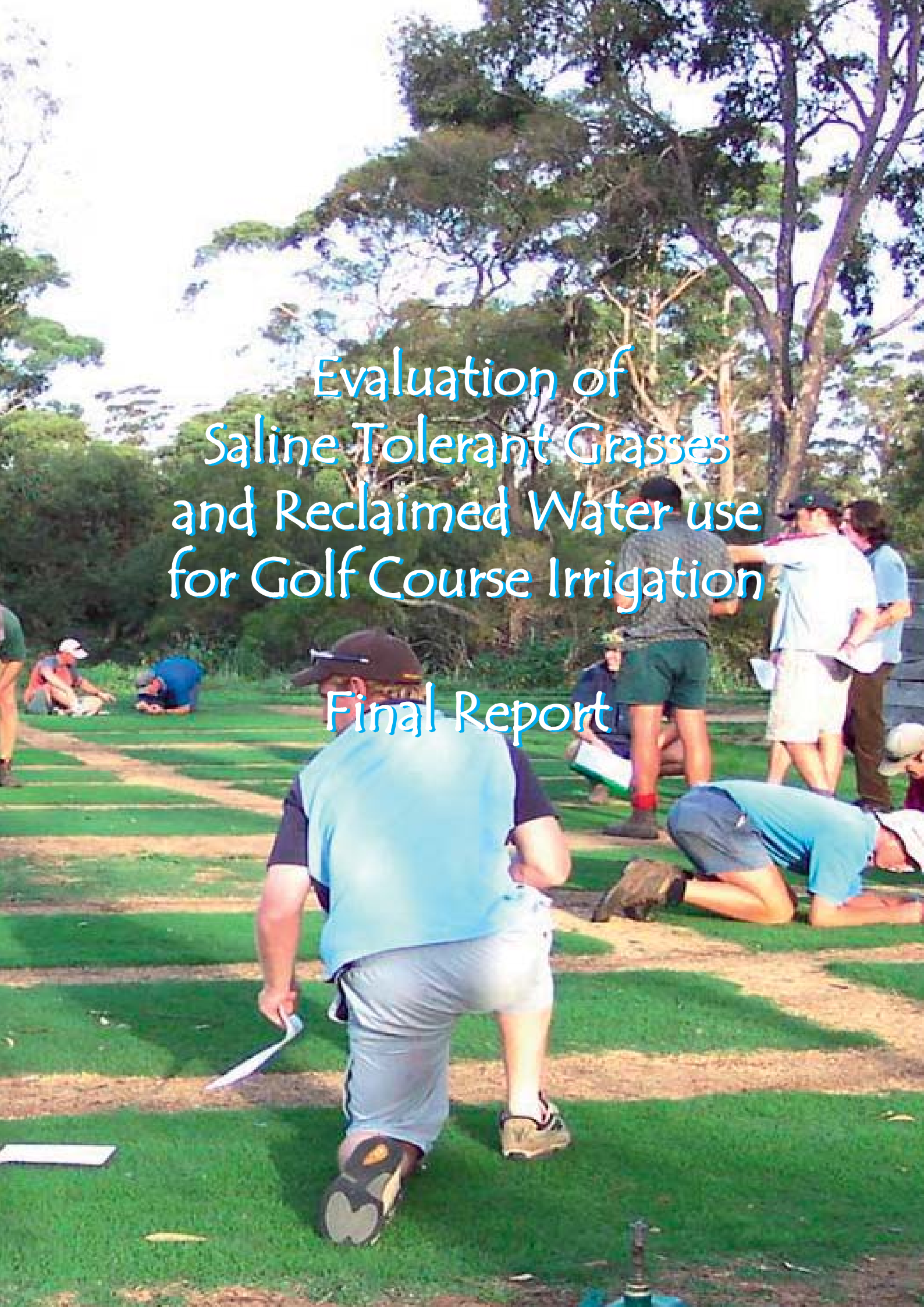

Evaluation of Saline Tolerant Grasses and Reclaimed Water use for Golf Course Irrigation

Final Report

Smart Water Fund (Round 2) Project:

Final Report - 2007

Objectives:
To report the final results of turfgrass quality assessments
and other aspects of trial work conducted for the Smartwater Fund.
This information is prepared in a colour brochure
format for dissemination of results to industry.

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A project carried out by the Victorian Golf Association Turf Research Board,
jointly funded by the Smart Water Fund
- an initiative of the Victorian water industry and the Victorian Government

Victorian Golf Association

Victorian Golf Foundation

Smart Water Fund
REPRESENTED BY
City West Water
Melbourne Water
South East Water
Yarra Valley Water
Department of Sustainability and Environment
Our Water Our Future
Victoria The Place To Be

Summary

Trial work was conducted at five different sites and in pot work to assess the drought tolerance and salinity tolerance of a range of turf species used on Victorian golf courses, and to evaluate the survival and turf quality of a range of new turf species and varieties in comparison with standard varieties.

A lysimeter (pot) trial showed that C_4 grasses such as couch, kikuyu, Paspalum and Zoysia have four major advantages during summer compared to C_3 grasses such as bent, ryegrass, Poa and fescues:

a) they use 25-30% less water on an average daily basis

b) their root systems become more effective through the summer, whereas C_3 roots decline

c) unlike C_3 grasses, C_4 grasses don't suffer summer Heat Stress and the related summer problems (eg: summer disease) that accompany Heat Stress, and

d) they respond rapidly to rain or irrigation after severe moisture stress, unlike C_3 grasses which are badly damaged and enter a long period of summer dormancy when they suffer moisture stress

The result of these advantages is that Turf Managers have a great deal of flexibility with irrigation of C_4 grasses, especially couchgrass, ranging from high water inputs if water is freely available (eg: effluent water) and a rapidly growing surface is required, down to zero irrigation where required, and anywhere in between those extremes. C_3 grasses don't have that flexibility.

A second pot trial showed that C_4 grasses had much greater tolerance to saline irrigation water when compared to C_3 grasses. Some of the C_4 grasses (Santa Ana couchgrass and Sea Isle 2000 Paspalum) actually tolerated straight sea water irrigation with very little damage.

The third part of the project was to evaluate and compare a range of new C_4 species and varieties in a range of conditions on Victorian golf courses. Older couch varieties, especially Santa Ana, still ranked very highly, and planting material is freely available. Newer couch varieties such as TifSport, Winter Gem and Conquest performed well and are suitable options for clubs looking for alternatives to the traditional varieties for fairways. Planting material of these proprietry varieties may be expensive or difficult to source. The variety that consistently showed the highest quality and shortest dormancy in a wide range of situations simulating fairway, tee and green conditions was CD. Unfortunately this variety is not commercially available, but the VGA will be working to provide clubs with planting material to trial over the coming summer.

Of the novel species, the *Paspalum vaginatum* variety Sea Isle 2000 performed well at some sites, and may have a role in our climate in very saline sites. Of the Zoysias, some potential exists for G1 and Palisades for niche uses (including lawns) but their growth in our climate is very slow and establishment would probably need to be from turf imported from northern states.

In conclusion, it is expected that Victorian golf clubs looking to move to C_4 grasses will have ample objective data from this report on water savings, salinity tolerance and variety performance to assist their decision making. Other turf sectors, including local government and the domestic turf market, should also benefit from the information.

Introduction

The main strategy to minimize the use of potable water on Victorian golf courses is to convert from C_3 grasses (eg: *Lolium, Agrostis, Poa or Fesctuca* species) to C_4 grasses (eg: *Cynodon, Paspalum, Pennisetum* or *Zoysia species*).

There are two main factors involved. First, C_4 grasses use much less water than C_3 grasses. Second, C_4 grasses perform much better on poor quality water compared to C_3 grasses. Earlier work by the Victorian Golf Association (Ford, 2000) identified that C_4 grasses, in particular couch grasses (*Cynodon dactylon*

and hybrids) provided the highest fairway turf quality of the general range of turf species grown in Victoria, and at the same time were able to survive on little or no irrigation in our climate. That report concluded that summer irrigation was 'optional' for the survival of couchgrass in the Victorian climate. The problem with C_4 grasses is their winter dormancy. VGA research and practical experience has shown that couch varieties such as Santa Ana, Wintergreen and Legend have the shortest length of winter dormancy, and so these varieties have been strongly promoted to the Victorian golf industry and widely adopted on fairways. One club (Kialla Golf Club) has recently established Santa Ana as a greens surface, with great success.

Since 2000 a number of further questions have been raised on this issue, leading to this current project. The amount of water saving from switching from C_3 grasses to C_4 grasses needed to be quantified. Also, the salinity tolerance of C_3 vs C_4 grasses needed to be demonstrated. And finally, an up-to-date variety trial was required to look at the survival, winter dormancy and turf quality of new species and varieties.

Trial Work

The trial work consisted of two pot trials conducted at the Northern Melbourne Institute of TAFE Horticulture campus (Fairfield), and a series of field trial sites. The pot trials measured water use and salinity tolerance, while the field trials assessed existing and new varieties in a range of different golf course situations. The five field trial sites selected are shown below, along with a short rationale:

1. Metropolitan Golf Club is located on the sandbelt, and provides excellent drainage. The plots are managed with low inputs of nitrogen and water, similar to the management of couch fairways on most sandbelt clubs.

2. Patterson River Country Club used Class C effluent water from the South Eastern plant, and offers a location to assess the grasses under non-potable irrigation. It should be stated that many golf clubs use Class C effluent water with absolutely no problems for the C_4 grass species being irrigated (although problems may occur with irrigation infrastructure, weed invasion etc).

3. Kerang Golf Club had two sets of plots, one maintained at greens height (4mm), and the second at fairway height on an area with a salinity problem so severe that grass growth had been impossible previously.

4. Riverside Golf Club plots are maintained at a mowing height of 8mm and high levels of irrigation and nitrogen. This situation is similar to tees and greens surrounds on golf clubs.

5. NMIT Horticulture Campus, Fairfield, plots were maintained at low mowing height to simulate greens conditions. These plots were exposed to severe drought conditions in the summer 2006/7.

The turf plots were established using vegetative material largely sourced from the Queensland Department of Primary Industries Turf Research unit at Redlands Bay. Turf leader at Qld. DPI, Dr. Don Loch, has built up planting material of several novel turf species and cultivars at Redlands Research Station, Cleveland, some of them Australian accessions and some of them from the US (released into Australia following a quarantine process). Dr. Loch also organized the supply of additional planting material from co-operative turf growers from Queensland (eg: Mr. Max Stephenson, Twin View Turf, Qld). Further planting material was sourced from Western Australia (Turf Farms WA) and locally (Evergreen Turf, Pakenham).

The novel species and cultivars being trialled were all Warm Season (C_4) grasses with special adaptations for drought, heat, salinity and/or shade tolerance. Most had not been grown in Victoria before. These

novel species were compared to various 'standards' such as Santa Ana, Legend, Tifdwarf and Wintergreen couch, which have been successfully used in Victoria for up to 25 years.

Planting material of twenty different couchgrass (and hybrid) varieties was sourced and planted. In addition to this, ten different Zoysia varieties and four Seashore Paspalum varieties were sourced and planted. None of these Zoysias or Paspalums had been grown in Victoria before.

Section 1: Comparison of C_3 vs C_4 grass water use

Introduction

Photosynthesis is the process whereby plants use the energy from sunlight and carbon dioxide from the atmosphere to synthesise carbohydrates. Most plant species on the planet use a photosynthetic pathway that initially forms a 3-carbon molecule (hence the term C_3 photosynthesis). But certain plant species that evolved in hot, arid climates have an adaptation to photosynthesis that performs more efficiently at higher temperatures and uses less water. The initial molecule in this mechanism has 4 carbons, hence the term C_4 photosynthesis.

The main C_3 turfgrasses are bentgrass, ryegrass, bluegrass and fescue. The main C_4 turfgrasses are couch, kikuyu, buffalo, Paspalum and Zoysia. C_4 grasses evolved in hot, arid climates and their method of photosynthesis is just one of several adaptations that give them an advantage over C_3 grasses in summer. They handle foliar Heat Stress better, their root systems are better suited to high soil temperatures, and their survival and recovery from severe drought is better.

There has been a strong trend since the 1980s for Victorian golf clubs to convert fairway surfaces from C_3 grasses to C_4 species, mainly couch. Couch has a quality advantage over other C_4 species. The Victorian Golf Association conducted trial work in the 1990s to assess fairway species under low water input (Ford, 2000) and came to the general conclusion that couchgrass fairways, especially the varieties Santa Ana, Legend and Wintergreen, offered excellent quality on little or no irrigation throughout Victoria.

While the industry has voted with its feet, there has been no objective measurement of water use and general 'irrigation requirement' of the various C_3 and C_4 species in Melbourne, so a trial was established in spring 2005 to test water use for the range of turfgrasses commonly used in Victoria.

Ten turfgrass species were grown in lysimeter pots, which are sealed containers where the only water lost each day is from direct evaporation through the turfgrass foliage. Weighing the pots each day allows the calculation of daily water use, also called Evapotranspiration (ET). A more complete discussion of this topic was addressed in the Milestone 2 report.

Two ET assessments were done, one in early summer (23rd Nov – 12th Dec 2005) and one in late summer (8th – 23rd Feb, 2006). After the second assessment the grasses were allowed to dry out completely and suffer extreme drought for 10 days, before they were watered and assessed for drought recovery and survival over the following 20 days. The lysimeters were then tipped out and root depths measured.

Results and Discussion

1. Early Summer

While there were some significant differences between C_3 species (eg: Bent used 5% more water than Red Fescue) and between C_4 species (eg: Paspalum used 11% more water than Zoysia), by far the the greater difference in water use was between the C_3 group and the C_4 group. C_4 grasses had ET rates and Crop Factors in the range 25-30 % less than C_3 grasses in the early summer period, as shown in Table 1.1:

Turfgrass Species	Total ET(mm)	Ratio to Couch	Mean ET (mm/day)	Mean Crop Factor
Creeping Bentgrass	81.8 [a]	133%	4.81	0.83
Tall Fescue	80.6 [a,b]	131%	4.74	0.84
Perennial Ryegrass	80.2 [a,b]	130%	4.72	0.81
Kentucky Bluegrass	77.9 [b]	126%	4.58	0.79
Fine Fescue	77.6 [b]	126%	4.56	0.86
Paspalum vaginatum	66.0 [c]	107%	3.88	0.66
Buffalo	63.9 [c,d]	104%	3.76	0.62
Kikuyu	62.2 [d,e]	101%	3.66	0.61
Couch	61.7 [d,e]	100%	3.63	0.61
Zoysia japonica	59.5 [e]	96%	3.5	0.59
Total Evaporation	90.6mm			
LSD (P = 0.05)	3.7			

Table 1: Total and mean ET figures and mean Crop Factors for the commonly used turfgrass species in the 17 days from 23/11 – 10/12/05, before moisture stress caused some grasses to drop out. Total ET readings followed by the same letter are not statistically significantly different.

After 17 days the C_3 grasses dropped out of the trial due to moisture stress. The C_4 grasses only lasted another 3 days before they, too, suffered visible moisture stress. In those 20 days the C_4 grasses reached a total ET of around 80mm (data not shown), the same as the C_3 grasses in their 17 days.

In summary, the C_3 grasses performed extremely well in early summer, no doubt due to a new, vigorous and efficient root system and very little hot weather to cause stress. They lasted 17 days on their moisture reserves, and extracted those reserves very well. The C_4 grasses used around 25-30 % less water than the C_3 grasses on a daily ET basis and on a daily Crop Factor basis. However they only lasted 2-3 days longer (20 days vs 17 days, a time increase of 18%) than the C_3 grasses before requiring irrigation.

2. Late Summer

Following the December assessment the grasses were watered back to full health and vigour, and irrigated as needed to main health over the summer. The assessment was run again in February 2006, after a long summer with some January temperatures in the 40's. The period of assessment, however (8th – 24th February) was unusually mild, with very few days in the 30's. The lysimeters were once again saturated and allowed to drain, then sealed up to allow daily weighing and ET measurement.

In the late summer assessment the C_3 grasses only lasted 7 days before showing visible moisture stress and in that time only used around 30mm from the pots, which is less than half of the water available to them.

Turfgrass Species	Total ET (mm) in first 7 days	Ratio to Couch	Crop Factor
Red Fescue	32.38 [ab]	1.26	0.91[a,b]
Perennial Ryegrass	30.95 [ab]	1.20	0.87[a,b]
Kentucky Bluegrass	33.80 [a]	1.31	0.95[a]
Tall Fescue	31.78 [ab]	1.23	0.90[a,b]
Dichondra	30.75 [b]	1.20	0.87 [b]
Buffalo	24.78 [c]	0.96	0.70 [c]
Kikuyu	25.20 [c]	0.98	0.71 [c]
Zoysia	27.15 [c]	1.06	0.76 [c]
Hybrid Couch	25.73 [c]	1.00	0.72 [c]
Paspalum	26.98 [c]	1.05	0.76 [c]
Couch (soil)	27.05 [c]	1.05	0.76 [c]
Total Evaporation	35.5		
LSD (P=0.05)	2.98		0.09

Table 2: Total ET and mean Crop Factor values for the commonly used turfgrass species in the 7 days from 8th – 14th Feb 2006, before moisture stress caused the C3 grasses to drop out. ET and Crop Factor values followed by the same letter are not statistically significantly different.

The C_4 grasses continued for a further 9 days before showing moisture stress, and their Total ET and mean Crop Factor values are shown below. The average temperature over those next 10 days was 29oC, substantially hotter than the first 7 days. The Crop Factors averaged around 0.8.

Turfgrass Species	Total ET (mm) in first 16 days	Ratio to Couch	Crop Factor
Buffalo	56.25 [c,d]	90%	0.73
Kikuyu	57.94 [b,c,d]	93%	0.75
Zoysia	62.13 [a,b,c]	100%	0.80
Hybrid Couch	62.27 [a,b,c]	100%	0.80
Paspalum	62.86 [a,b]	101%	0.81
Total Evaporation	77.49		
LSD (P=0.05)	6.47		0.08

Table 3: Total ET and Crop Factors values for the C4 grasses in the 17 days from 8th – 24th Feb 2006, before moisture stress occurred. ET and Crop Factor values followed by the same letter are not statistically significantly different.

In summary, the C_3 grasses only lasted 7 days and exploited around 30mm of moisture from the lysimeter pots before visible symptoms of moisture stress appeared. There was plenty of water left in the pots that went unused. The average temperature of those 7 days was 23°C, so excessive heat cannot be blamed. It seems that root dysfunction is the problem for C_3 grasses by the end of summer, although this trial had no way of measuring this directly. The general turfgrass literature describes the inefficiency and 'root dysfunction' of C_3 grasses late in the summer, and it appears to explain the findings here.

In contrast the C_4 grasses lasted a further 10 days before moisture stress symptoms appeared. By that time they had exploited around 60mm of water from the lysimeter pots, around twice that sourced by the C_3 grasses. While average Crop Factors of the C_4 grasses were only 15 – 20% lower than the C_3 grasses, other factors (probably root function/dysfunction) meant that C_4 grasses lasted considerably longer than C_3 grasses before showing visible moisture stress.

As each species suffered visible moisture stress it was removed from the trial. Instead of re-watering the pots, however, they were left exposed in the sunshine for a further 10 days, causing them severe drought stress. They were then re-watered, and assessed 10 days and 20 days later for survival and recovery. The results are depicted in Graph 1.

Couch grass showed a rapid recovery from severe drought stress. It's possible this species is able to 'resurrect' droughted shoot tissue, simply re-hydrating the existing tissue to provide rapid recovery. This is the behaviour seen in the field, where severely droughted couch fairways and lawns exhibit a rapid recovery after rainfall or irrigation.

In the case of Buffalo and Kikuyu, one of the four replicates in each case had droughted severely enough that rehydration and resurrection of existing tissue did not occur (although in the other three replicates it did), so the recovery at 10 days wasn't as good as couch. But by 20 days the recovery from underground tissues had achieved a full recovery of these two species.

Zoysia had only a partial recovery, and Paspalum had poor survival and recovery from severe drought.

Of the Cool Season Grasses, only Kentucky Bluegrass has rhizomes and these were probably the reason that it made a substantial recovery from a severe period of drought stress. All the other C_3 grasses had poor and unacceptable recovery.

These results highlight the inflexibility of irrigation of C_3 grasses – unless the Turf Manager is able to reliably irrigate these grasses at the first signs of stress, right through the summer, then a large proportion of the plants will die and the sward will be lost. This, again, corroborates what is seen in the field.

With couch, and to a less extent kikuyu and buffalo, this is not the case. These grasses can be allowed to go into considerable moisture stress and will recover rapidly when rainfall or irrigation is applied,

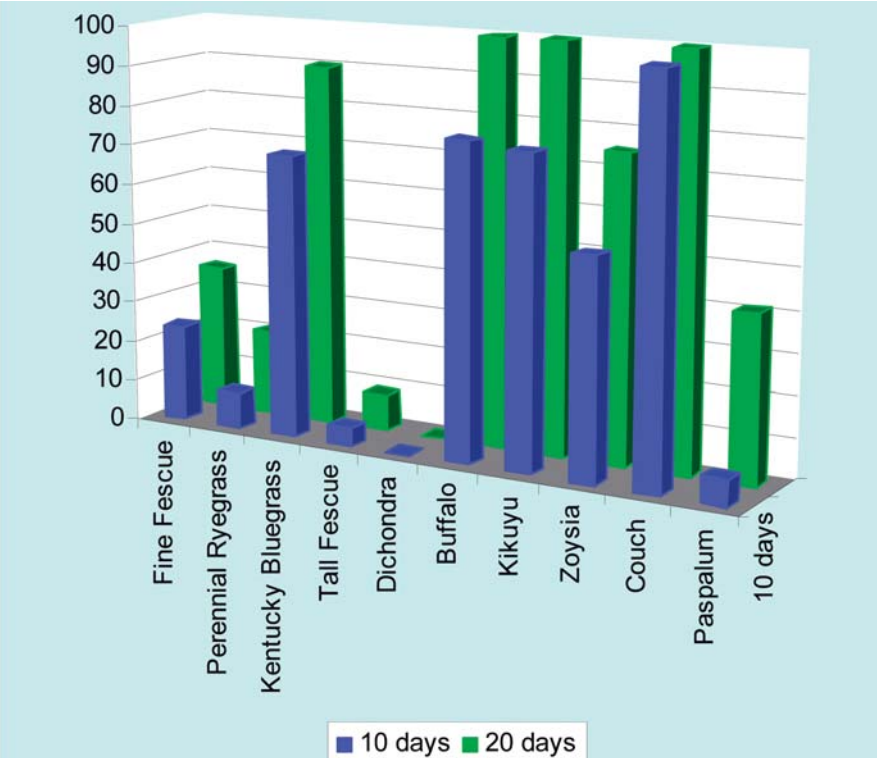


Fig 1: Percentage living groundcover of turfgrass species at 10 and 20 days after rewatering from severe drought stress (mean of four replicates).

and this creates a great deal more flexibility for the Turf Manger. Couchgrass has an advantage over kikuyu and buffalo, while allowing Zoysia to go into moisture stress is risky. Severe moisture stress must be avoided on Seashore Paspalum.

Discussion: Couch vs C_3 grass fairways

So is this data consistent with observations of drought resistance of C_3 and C_4 fairways in Melbourne? Yes, it is. Couch has a substantially lower ET rate and Crop Factor value compared to C_3 grasses. In the field it will produce a deep and functional root system that doesn't deteriorate as the summer progresses and is very efficient at exploiting the moisture available in the rootzone. These two points alone mean that it requires much less irrigation than C_3 grasses, but as a fallback position it is able to tolerate tissue dehydration and has a good ability to re-hydrate immediately water becomes available again. These points explain the field observations that couch can provide excellent fairway quality on low irrigation inputs, applied sparingly and infrequently. There is a great deal of flexibility in how the irrigation is applied without risk to couch survival. If irrigation water is not provided at all the couch will eventually suffer moisture stress but will rapidly recover in the event of rainfall or irrigation.

Cool season grasses probably have a dysfunctional root system in late summer due to Heat Stress and high soil temperatures. This explains the necessity to water these grasses little and often (eg: 15 minutes every 2 days). The root dysfunction and inability of C_3 grasses to exploit what moisture is there in the soil means their drought resistance is only a fraction of that of C_4 grasses by late summer. Added to that, if they suffer drought stress due to pump failure or the club running out of water, then their survival and recovery from that will be poor (generally the sward will be lost).

There are undoubtedly other factors involved in these differences. C_3 grasses can suffer considerable damage from Heat Stress related summer fungal diseases, while C_4 grasses suffer very few summer disease problems.

Section 2: Turfgrass Performance with Saline Water sources

Introduction

With the current climatic and water situation Turf Managers are being forced to look at alternative water sources such as bore water, effluent water, recycled water or even sea water. The salinity of this irrigation water can limit its use due to the damage it would cause to the turfgrass and the soil. It is well known that certain species tolerate higher salt levels than others, and the recent introduction of Seashore Paspalum (*Paspalum vaginatum*) cultivars with high turfgrass quality has raised the bar in what is achievable with poor quality water. In some golf courses in the US, Seashore Paspalum has occasionally been watered with sea water.

Other trials have shown that the Seashore Paspalum cultivars 'Velvetene' and 'Sea Isle 2000' grow quite vigorously in Melbourne's climate, with good turf quality and short winter dormancy. Local trial work is needed to compare the salinity tolerance of Seashore Paspalum with *Cynodon dactylon* and other locally grown turf species to quantify the responses to saline irrigation water.

Salinity damage takes several forms, such as physiological drought, foliar burn, specific toxicities from sodium or chlorine, or sodic effects on soil structure. The damage may be caused directly by saline water on the leaves or by the accumulation of salts in the soil over time. The pots used in this experiment used a sandy soil with low clay content and high leaching ability, so this trial concentrates on the foliar burn and toxicity effects, as measured by root depth and root weight, survival of leaf tissue and maintenance of turf quality under higher salinity levels.

The aim of the trial is to compare the tolerance of the major turfgrass species grown in Melbourne when irrigated with highly saline water over the summer period.

Trial Work

A trial was established in the spring of 2005 to test the response of the major turfgrass species to saline irrigation water over the following summer. Nine turfgrass species were established in pots. After an establishment period to allow the grasses to produce deep roots and mature shoot tissue, salinity treatments were slowly introduced.

The four salinity treatments were:
1. Town water
2. Two thirds town water to one third sea water (19.3 dS/m)
3. Half town water to half sea water (29 dS/m)
4. Full sea water (58 dS/m)

The salinity treatments were phased in over a period of one month (November) to allow the grasses to adapt to increasing salt levels in the irrigation water. Once the full treatment level was reached, irrigation with that level continued for a further month (December through to January 2006). Treatment water was applied three times per week at a rate of 10mm each application. The pots were in an outside location, exposed to normal sunlight and rainfall. A total of 133mm of rainfall fell during that period.

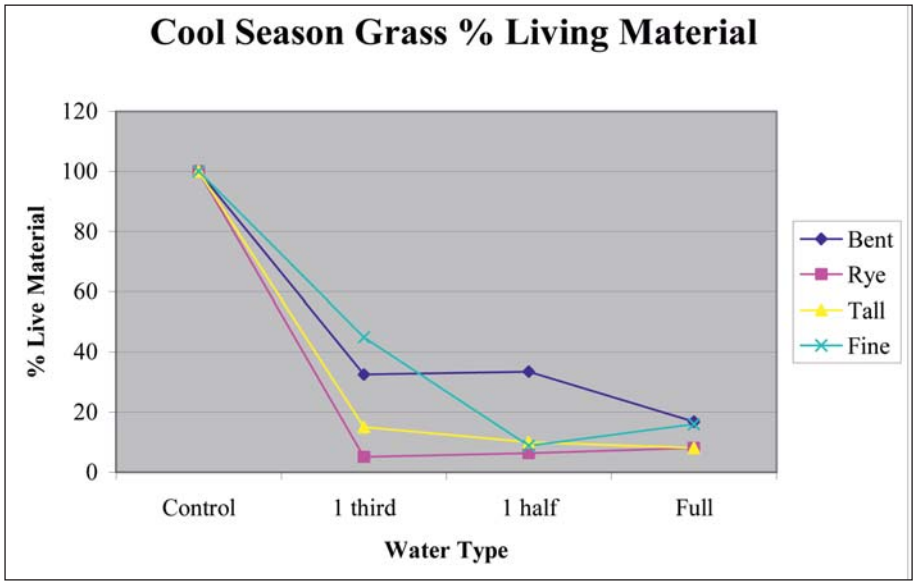
Results

1. Survival

Graphs 2.1 and 2.2 indicate the survival (% living foliage after one month of treatment) of each species at increasing levels of salinity of irrigation water. The C_3 (Cool Season) grasses had very low tolerance, although the Creeping Bentgrass (cultivar JCI-2-22) and Fine Fescue (cv. ZI-4-245) had some surviving

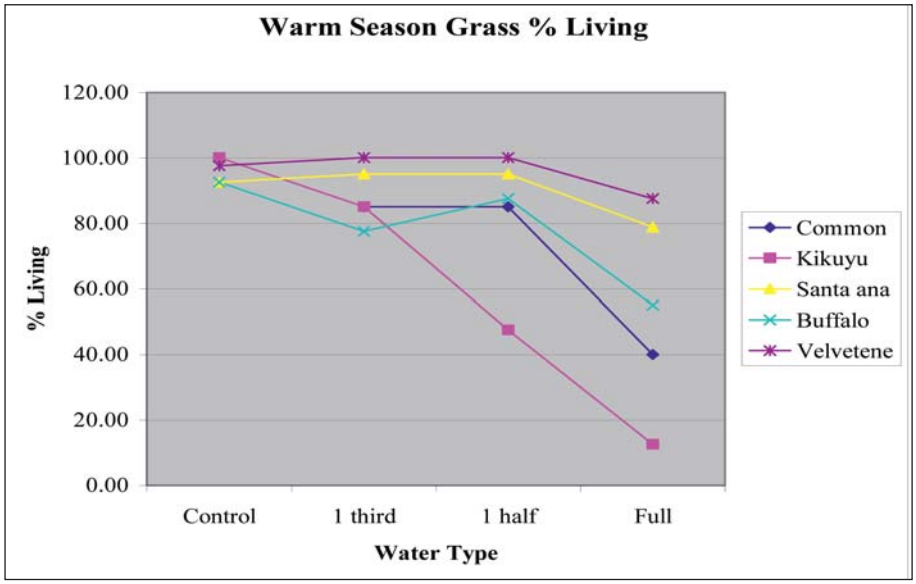
plants at 1/3 sea water treatment (19.3 dS/m). Tall Fescue (cv. SR8600) and Perennial Ryegrass (cv. SR4220) did not survive any of the salinity water treatments except the control (town water).

Cool Season Grass % Living Material



Graph 2: Survival of C_3 grasses with saline irrigation

Warm Season Grass % Living



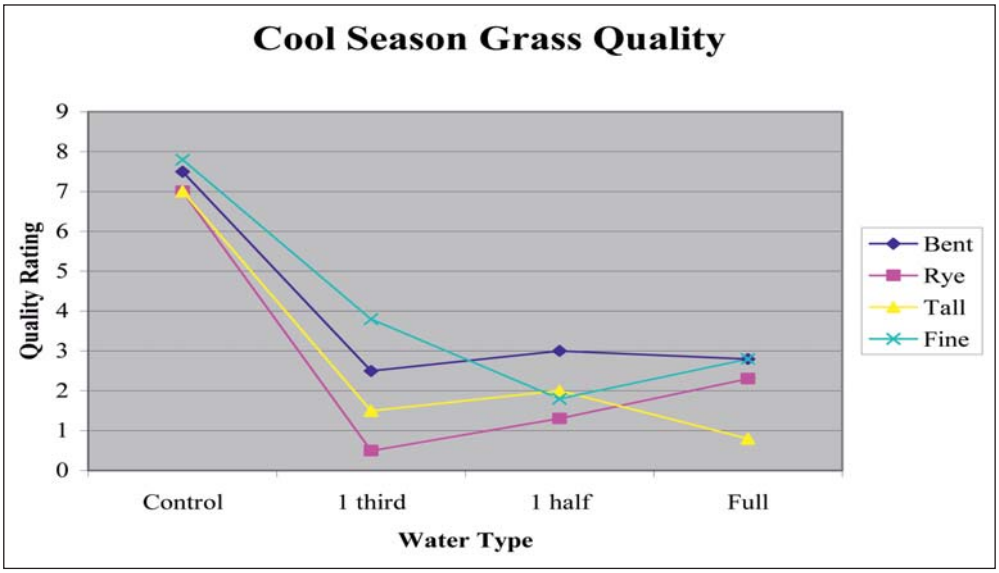
Graph 3: Survival of C_4 grasses with saline irrigation

Of the C_4 (Warm Season) grasses, kikuyu (common variety) suffered severe damage at the half and full seawater rates. Common couch (var. Legend) and Buffalo (cv. Sir Walter) were badly damaged by the full seawater treatment. As expected the Seashore Paspalum (cv. Velvetene) tolerated full seawater irrigation, but surprisingly the hybrid couch cultivar Santa Ana did as well.

2. Quality

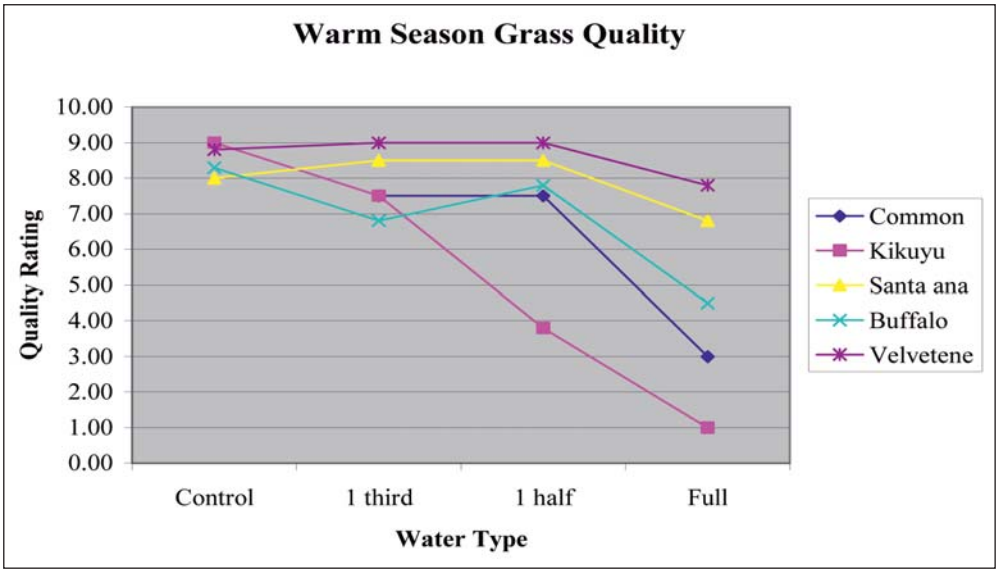
Graphs 2.3 and 2.4 summarise the quality ratings. Only the Fine Fescue maintained anything like acceptable quality at the 19.3 dS/m level. Velvetene Seashore Paspalum and Santa Ana hybrid couch maintained excellent turf quality even under full seawater irrigation. Kikuyu quality deteriorated rapidly under the half seawater and full seawater treatments.

Cool Season Grass Quality



Graph 4: Quality ratings (0 – 9 scale) of C_3 grasses with saline irrigation

Warm Season Grass Quality



Graph 5: Quality ratings of C_4 grasses with saline irrigation

3. Soil Salinity

The soil salinity (Electrical Conductivity of a 1:5 soil:water extract) at the conclusion of the trial work was reasonably low because of the high permeability and low clay content of the growing medium, and the fact that the pots were subject to natural rainfall. Mean EC levels were 0.2dS/m for the control pots (town water irrigation), 1.3dS/m for the one third sea water treatments, 1.5dS/m for the half sea water treatments and 2.4dS/m for the full seawater treatments.

Discussion

The trial indicates only how each species survived under saline irrigation. Soil salinity levels stayed reasonably low due to the high leaching, low clay content and exposure to natural rainfall.

It does indicate, however, the high tolerance of both Seashore Paspalum and Santa Ana hybrid couch to highly saline water, to the level of sea water. In many turf situations where similar profiles are found

(eg: coastal dunes golf courses, sand-based constructed profiles) it should be possible to irrigate with highly saline water and be confident that quality won't suffer.

The trial clearly shows that there are differences between species with tolerance to saline irrigation water. C_3 grasses are uniformly intolerant, and of the C_4 species kikuyu is the least tolerant.

Conclusions

1. Most C_3 grasses were killed at the one third and higher seawater levels. Creeping Bentgrass and Fine Fescue performed better than the Tall Fescue and Perennial Ryegrass, and had some survival of saline irrigation at the one third seawater level (19.3 dS/m), but presented unacceptable quality at that level.
2. Of the C_4 grasses, kikuyu showed the poorest survival and quality response to increasing salinity of irrigation water. Buffalo and Common couch showed reasonable tolerance to the half seawater treatment.
3. Seashore Paspalum and Santa Ana hybrid couch showed the best tolerance to saline irrigation, to the point that quality and survival were acceptable even when irrigated with the full seawater treatment (58 dS/m).

Seashore Paspalum

Buffalo

Santa Ana Hybrid couch

Kikuyu

Common couch

Photo 1: C_4 grasses under full sea water irrigation, at the completion of the trial

Section 3: Field plot performance of C_4 grasses

Turfgrasses were established by Turf Management students from Northern Melbourne Institute of TAFE at the five trial sites in summer 2004/5. Following establishment the plots were assessed at the start of each season, four times per year until March 2007.

The plots were rated for quality and colour on a 0 – 9 scale, where 9 = best quality or greenest colour. Such ratings are rather subjective, but are valid if done by two or more independent and experienced

assessors. It is the standard rating technique used in the international turf area (ref: National Turf Evaluation Program).

Quality is a visual assessment mainly focused on density and uniformity of the sward. Quality ratings below 4.5 indicate unacceptable quality. Colour assessment is not an aesthetic judgement, but is simply used to indicate if a grass is actively growing or not. Colour ratings below 4 usually indicate a dormant period, which can occur in winter due to sub-optimal temperatures, or during summer due to drought stress.

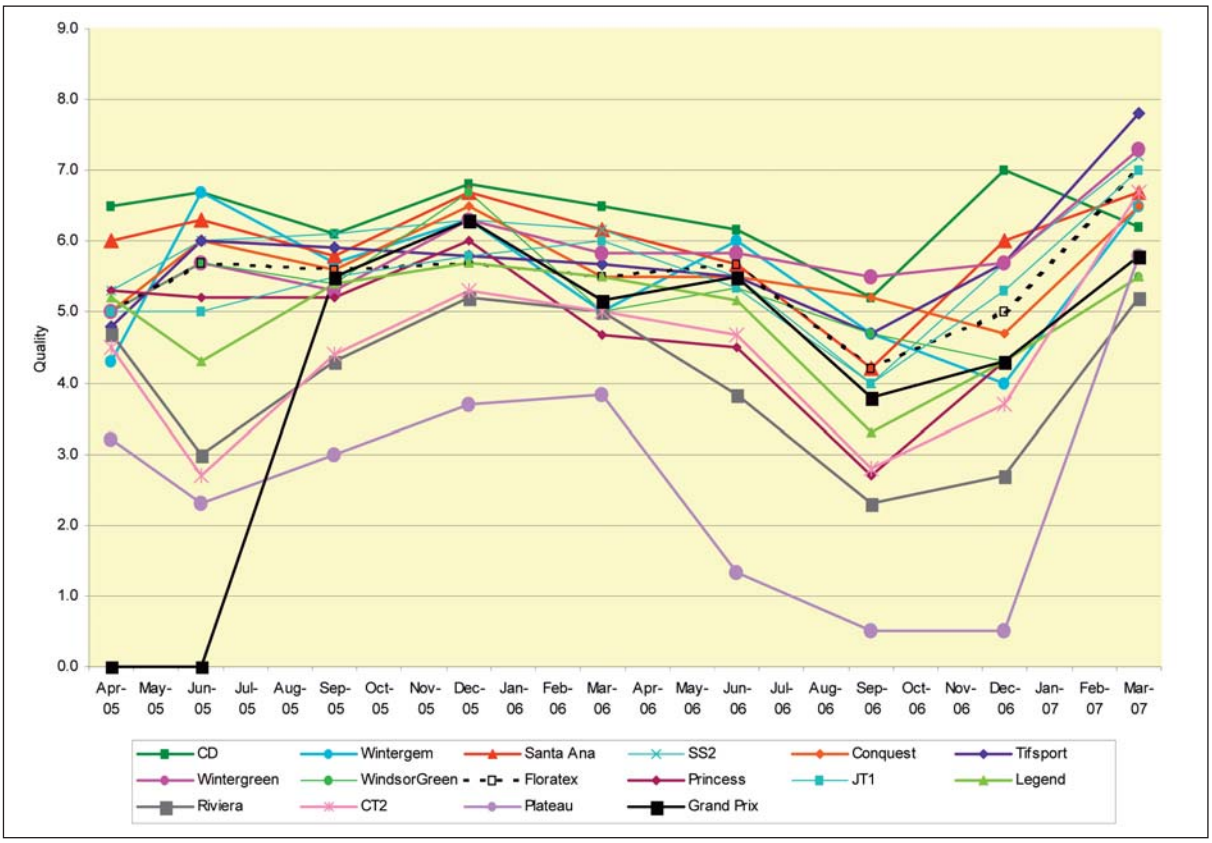
Most of the trial sites had three replicate plots of each variety, so the rating score in each case is the mean of the three replicate plots. Replication of plots allows the numbers to be statistically analysed, specifically looking for 'least significant difference' (LSD) between the varieties. If the ratings for two varieties is not different by at least that LSD value, then statistically we cannot say one grass was better than the other. If the difference in ratings between two varieties is greater than the LSD value, then we can say with confidence that one variety was better than the other.

A shortcut when doing this is to look for the highest rating value at the assessment time, then subtract the LSD value from that. Any variety with a score within that range is in the top group, and that's generally what you are interested in. A variety that ranks consistently in the top group for both quality and colour is desirable. For convenience, ratings in the top group are denoted with the superscript 'a' in the tables. The results are displayed in tables and graphs, with a brief discussion of each site. A more general discussion, conclusion and recommendations will follow.

1. Couch trial at Metropolitan Golf Club: Three replicate plots of sixteen couchgrass (*Cynodon dactylon* and hybrids) varieties were managed at a similar level of inputs to most sandbelt couchgrass fairways, with limited inputs of nitrogen and water.

Summary: The variety CD had the best performance overall, ranking in the top group on each occasion. Unfortunately CD is not commercially available, and is not likely to become available for several years at best. The next most consistent varieties were Santa Ana, SS2, Conquest, TifSport and Wintergreen, which all ranked in the top group in 8 out of the 9 assessments. The trial indicates that any of these will perform well in our climate and conditions. Several other varieties such as FloraTex, Windsor Green, Winter Gem and Grand Prix performed consistently well and will probably perform very well. Three varieties stood out for poor performance, however, Riviera, CT-2 and Plateau. These varieties are definitely not recommended for Victorian conditions.

Quality	Apr-05	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
CD	6.5[a]	6.7[a]	6.1[a]	6.8[a]	6.5[a]	6.2[a]	5.2[a]	7.0[a]	6.2[a]
Winter Gem	4.3	6.7[a]	5.7[a]	6.3[a]	5.0	6.0[a]	4.7[a]	4.0	6.5[a]
Santa Ana	6.0[a]	6.3[a]	5.8[a]	6.7[a]	6.2[a]	5.7[a]	4.2	6.0[a]	6.7[a]
SS2	5.3[a]	6.0[a]	6.1[a]	6.3[a]	6.2[a]	5.5[a]	4.0	5.7[a]	7.2[a]
Conquest	5.0[a]	6.0[a]	5.6[a]	6.5[a]	5.5	5.5[a]	5.2[a]	4.7[a]	6.5[a]
TifSport	4.8[a]	6.0[a]	5.9[a]	5.8	5.7[a]	5.5[a]	4.7[a]	5.7[a]	7.8[a]
Wintergreen	5.0[a]	5.7[a]	5.3	6.3[a]	5.8[a]	5.8[a]	5.5[a]	5.7[a]	7.3[a]
Windsor Green	5.0[a]	5.7[a]	5.4	6.7[a]	5.0	5.3[a]	4.7[a]	4.3	5.5
FloraTex	5.0[a]	5.7[a]	5.6[a]	5.7	5.5	5.7[a]	4.2	5.0	7.0[a]
Princess	5.3[a]	5.2[a]	5.2	6.0	4.7	4.5	2.7	4.3	5.8
JT1	5.0[a]	5.0[a]	5.5[a]	5.8	6.0[a]	5.3[a]	4.0	5.3	7.0
Legend	5.2[a]	4.3	5.4	5.7	5.5	5.2	3.3	4.3	5.5
Riviera	4.7[a]	3.0	4.3	5.2	5.0	3.8	2.3	2.7	5.2
CT-2	4.5	2.7	4.4	5.3	5.0	4.7	2.8	3.7	6.7[a]
Plateau	3.2	2.3	3.0	3.7	3.8	1.3	0.5	0.5	5.8
Grand Prix	n/a	n/a	5.5[a]	6.3[a]	5.2	5.5[a]	3.8	4.3	5.8
LSD (P = 0.05)	1.8	1.8	0.6	0.7	0.9	0.9	1.0	2.3	1.7

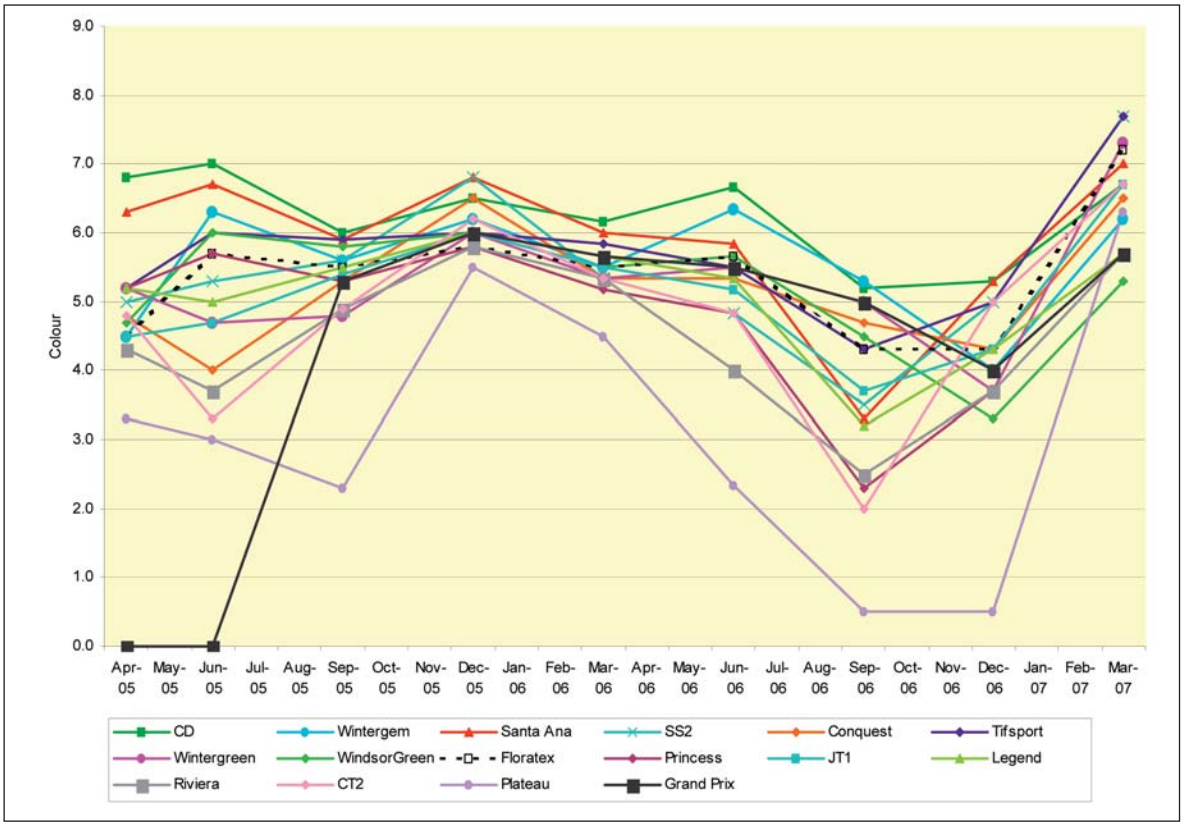


Graph 6: Quality ratings (0 – 9) of couch plots at Metropolitan Golf Club, April 2005 – March 2007.

Colour	Apr-05	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
CD	6.8[a]	7.0[a]	6.0[a]	6.5[a]	6.2[a]	6.7[a]	5.2[a]	5.3[a]	6.7[a]
Winter Gem	4.5	6.3[a]	5.6[a]	6.2	5.5	6.3[a]	5.3[a]	4.0[a]	6.2[a]
Santa Ana	6.3[a]	6.7[a]	5.9[a]	6.8[a]	6.0[a]	5.8[a]	3.3	5.3[a]	7.0[a]
SS2	5.0	5.3	5.6[a]	6.8[a]	5.3	4.8[a]	3.5	5.0[a]	7.7[a]
Conquest	4.8	4.0	5.3	6.5[a]	5.3	5.3	4.7[a]	4.3[a]	6.5[a]
TifSport	5.2	6.0[a]	5.9[a]	6.0	5.8[a]	5.5	4.3	5.0[a]	7.7[a]
Wintergreen	5.2	4.7	4.8	6.0	5.3	5.5	5.0[a]	3.7[a]	7.3[a]
Windsor Green	4.7	6.0[a]	5.8[a]	6.0	5.5	5.7[a]	4.5[a]	3.3[a]	5.3
FloraTex	4.5	5.7[a]	5.5[a]	5.8	5.5	5.7[a]	4.3[a]	4.3[a]	7.2[a]
Princess	5.2	5.7[a]	5.3	5.8	5.2	4.8	2.3	3.7[a]	5.7
JT1	4.5	4.7	5.4[a]	6.0	5.5	5.2	3.7	4.3[a]	6.7[a]
Legend	5.2	5.0	5.5[a]	6.0	5.7[a]	5.3	3.2	4.3[a]	5.7
Riviera	4.3	3.7	4.9	5.8	5.3	4.0	2.5	3.7[a]	5.7
CT-2	4.8	3.3	4.9	6.2	5.3	4.8	2.0	5.0[a]	6.7[a]
Plateau	3.3	3.0	2.3	5.5	4.5	2.3	0.5	0.5	6.3[a]
Grand Prix	n/a	n/a	5.3	6.0	5.7[a]	5.5	5.0[a]	4.0[a]	5.7
LSD (P = 0.05)	1.5	1.6	0.6	0.5	0.6	1.0	1.1	2.3	1.5

Table 4: Colour ratings (0 – 9) of couch plots at Metropolitan Golf Club, April 2005 – March 2007.

Summary: Once again CD was the only variety to rank in the top group on each occasion. The June and September ratings are the key, indicating how early a variety goes into dormancy and how long it takes to recover in the spring time. As well as CD, Winter Gem, FloraTex and Windsor Green ranked in the top group in each of the June and September ratings. Santa Ana, long regarded as our shortest dormancy couchgrass, rated consistently well but it seems there are others of equal or even shorter dormancy. Winter dormancy results in minimal growth and recovery, poor aesthetics and increased susceptibility to damage from the fungal disease Spring Dead Spot. Dormancy and winter colour can be affected by cultural management, but under uniform conditions like these plots, differences in winter dormancy are largely genetic. Given that Victoria does not experience conditions of Winter Kill (temperatures below – 7°C) that would threaten couch survival, there is every reason to select a variety with short winter dormancy. CD, Winter Gem, FloraTex, Windsor Green and Santa Ana could all be considered short dormancy varieties. At the other end of the scale, Plateau, CT-2 and Riviera show a long dormancy and slow spring recovery.



Graph 7: Colour ratings (0 – 9) of couch plots at Metropolitan Golf Club, April 2005 – March 2007.

2. Novel species trial at Metropolitan Golf Club: this was the first planting in Victoria of most of these grasses, and their simple survival needed to be assessed before any further work was warranted, so single replicates were considered adequate. The following two tables summarise the quality and colour ratings over the trial period, and a short discussion follows:

Quality	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Paspalums							
Sea Isle 2000	5.8	5.5	5	5.5	3.5	2	5.0
Sea Isle 1	5.5	6	4.5	4	3.5	2	4.0
Saltene	5.3	5	5.5	5	3.5	7	5.0
Velvetene	6	5.5	4	3	3	1	4.0
Zoysias							
G1	5.5	7	4	4.5	5	6	6.0
Palisades	6.5	6.5	5.5	6	6	5	7.0
Diamond	4	5	1.5	0.5	0.5	1	2.0
Zoyboy	4.8	5.5	3	2.5	2	3	3.0
Cavalier	4.5	4	2	2	1.5	1	1.5
Zorro	3	3	1.5	1	1	2	2.5
Empire	5 5.	5	4.5	3.5	3	3	4.0
Emerald	4	6	2.5	2.5	2	3	3.5
ZT11	4.8	5.5	3.5	4	3	3	4.0
ZT94	3	3	2	0	0	1	2.0
Jumar	5 5.	5	5.5	5	4.5	4	4.0
Royal	4.8	3	2	1	1.5	1	2.0
Ultradwarfs							
TifEagle	1	3	4	2	2	2	4.0
MS-Supreme	1	3	3.5	1	0.5	1	5.0
FloraDwarf	1.5	3	3	1	0.5	1	3.5

Colour	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Paspalums							
Sea Isle 2000	6.5	7	5	7	6.5	2	6
Sea Isle 1	5.8	7	5	6.5	5	3	6
Saltene	5.8	7	5	6	5	7	6
Velvetene	7	7	5	7	6	1	6.5
Zoysias							
G1	6.5	7	5	6.5	6.5	5	7
Palisades	6	5	5.5	5.5	5	4	6
Diamond	5.3	4	5	5	4	3	4
Zoyboy	5.5	5.5	5	5.5	4	2	4
Cavalier	5	4	5	5.5	4	2	5
Zorro	4.5	3	5	5	4	2	5
Empire	5.3	5.5	5	5	2.5	3	5.5
Emerald	6	5.5	5	5	5	2	5.5
ZT11	5.8	5.5	5.5	6.5	5	4	5.5
ZT94	5	5	5	0	0	1	5
Jumar	5.5	5.5	5.5	5	4	4	5
Royal	5	2	5	4.5	3.5	2	4.5
Ultradwarfs							
TifEagle	2	5	5.5	3.5	3	4	5.5
MS-Supreme	2	5	5.5	5	3	5	5.5
FloraDwarf	3	5.5	5.5	5	4	3	5.5

Discussion: novel species at Metropolitan Golf Club

1. *Paspalum vaginatum* (Seashore Paspalum): this species has excellent salt tolerance, and possibly its true quality only emerges under saline conditions. At this site the water quality and the soil drainage was good, so salinity levels were very low. The establishment of all four varieties was rapid and their early quality and winter colour was similar to that of the best couch varieties. Their quality declined, however, probably due to drought stress. Our plots indicate that the Paspalums don't have drought tolerance as effective as the Cynodon couchgrasses, and we conclude that this species may have a role in highly saline sites (ie: highly saline irrigation water or soils), but only where irrigation water is in ready supply. The fairway plots at Kerang Golf Club corroborate this.

2. Zoysias: these species originate in tropical areas of Asia. All the varieties trialled managed to survive, but only two or three showed any real potential for our climate. The *Zoysia matrella* variety G1 and the *Zoysia japonica* varieties Palisades and (to a lesser extent) Empire maintained reasonable growth and quality over the life of the trial, enough to warrant further trialling in niche areas such as bunker faces, domestic lawns and parklands. The establishment rate from sprigging and plugging was extremely slow,

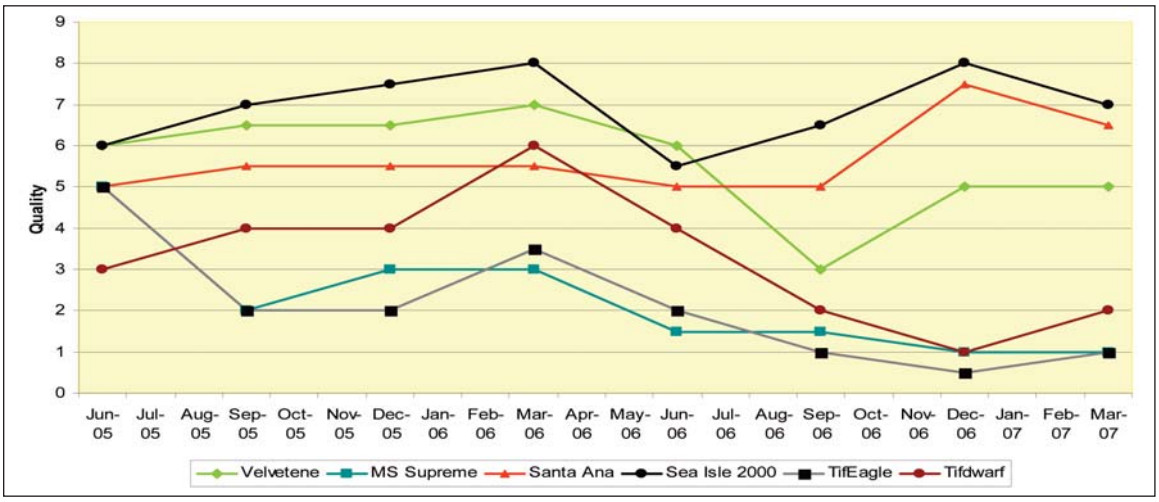
but it is feasible to import turf from northern states during our summer. Empire is actually grown here commercially (Lilydale Turf Farm) and has proved reasonably successful in local applications.

3. Ultradwarf couch: these varieties are bred specifically for golf greens in tropical and sub-tropical climates, and while their density and quality is extraordinary their winter performance severely limits their potential in our southern climate. As well as long winter dormancy, the three varieties tested all showed severe damage from the fungal disease Spring Dead Spot. This disease can be controlled quite effectively with the fungicide propiconazole, but our plots at Metropolitan received no fungicide. This perhaps highlights the limitations of trial work – in plots we are looking to identify and highlight genetic weaknesses, whereas for a surface in play you are looking to hide or compensate for any weaknesses to present a green in the best condition. At Middle Park Bowling Club, for example, a TifEagle bowling green provided with good management of water and nutrition and the appropriate fungicide has performed beautifully.

4. Greens trial at Kerang Golf Club

A practice putting green at Kerang was sown with six different grasses to assess their potential as a putting surface. The green was maintained at 4mm mowing height and received similar cultural management to the existing greens, although irrigation was much reduced on an 'as needs' basis. Only one replicate of each variety was sown in order to keep each plot reasonably large, so statistical analysis was not possible. The trial did provide some important results, however, as summarized and discussed below:

Quality	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Velvetene	6	6.5	6.5	7	6	3	5	5
MS-Supreme	5	2	3	3	1.5	1.5	1	1
Santa Ana	5	5.5	5.5	5.5	5	5	7.5	6.5
Sea Isle 2000	6	7	7.5	8	5.5	6.5	8	7
TifEagle	5	2	2	3.5	2	1	0.5	1
Tifdwarf	3	4	4	6	4	2	1	2



Colour	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Velvetene	3	5	7	8	5	5	7	8
MS-Supreme	1	7	5	2	2	1.5	6	2
Santa Ana	6	4	5.5	4.5	4.5	5	7	7.5
Sea Isle 2000	3	5	8	8	4.5	6	7	6.5
TifEagle	1.5	6.5	4	2	2	1	6	2
Tifdwarf	1	6	6	6	3	2	5	2

Discussion

In these plots the TifEagle and MS-Supreme performed just as poorly as in the Metropolitan Golf Club plots. Without fungicide application and in our climate, with the long dormancy these varieties show, the disease Spring Dead Spot was devastating. The performance of Santa Ana and Sea Isle 2000, however, was excellent. Sea Isle 2000 is a Paspalum, not a Cynodon couch, and appears to be resistant to Spring Dead Spot (as the front cover of this report shows). There is real potential for clubs looking to grow a

C_4 grass putting surface to trial Sea Isle 2000, especially if their water supply is saline. Tifdwarf and Santa Ana provide a good putting surface, Santa Ana being coarser than Tifdwarf but having a shorter dormancy period. An advantage with both these varieties is their long history in Victoria, which makes for a ready supply of sprigs (and management advice) should a club elect to convert over to them. Kialla Golf Club has established 18 Santa Ana greens in the summers of 2004/5 and 2005/6, with great success.

C_4 grass putting greens need to be looked at by clubs poor water supply or poor water quality. The benefits would be similar to those when converting fairways to C_4 grasses – lower water requirement and a very flexible approach to irrigation, even to the extent of cutting water off for long periods if necessary. In the case of greens, however, other benefits would apply due to the summer hardiness and tolerance to Heat Stress of the C_4 grasses.

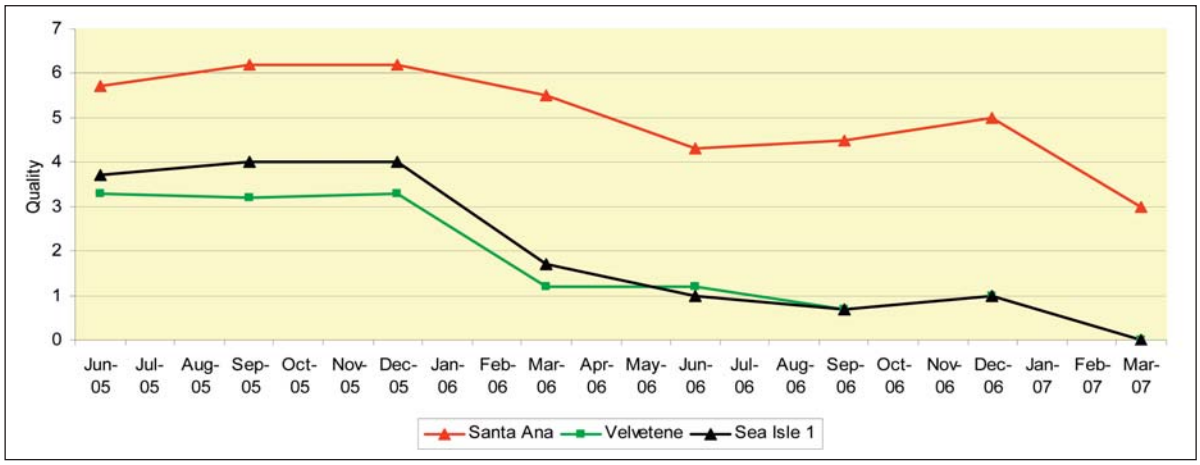
The choice of species/variety depends on the situation – if water is highly saline but in abundant supply, Sea Isle 2000 would work well although there would be a steep learning curve as this grass has different cultural requirements to our traditional grasses. If water is both saline and in short supply, Santa Ana would do a good job. If a finer textured grass was required, Tifdwarf would work well, and probably TifEagle or MS-Supreme would work, but one or two applications of the fungicide propiconazole would be required. These last three grasses also have a long dormancy period, which probably wouldn't suit a club with a lot of winter golf.

5. Fairway trial at Kerang

An area of the 4th fairway at Kerang had been unable to support grass growth for several years due to high salinity. At the time of planting a white crust of salt was visible on some bare areas of the site, and soil salinity readings were up to 14,000 ppm. Santa Ana hybrid couch and the Paspalum vaginatum varieties Velvetene and Sea Isle 1 were planted and generously watered in the summer of 2004/5. In the summers of 2005/6 and 2006/7, however, the area was not irrigated to let the salts build up. The results are summarized in the following tables and graph:

Quality	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Santa Ana	5.7	6.2	6.2	5.5	4.3	4.5	5.0	3
Velvetene	3.3	3.2	3.3	1.2	1.2	0.7	1.0	0
Sea Isle 1	3.7	4.0	4.0	1.7	1.0	0.7	1.0	0
LSD (P=0.05)	1.2	1.1	1.6	0.7	0.8	0.7	1.0	

Table 5: Quality ratings of fairway plots at Kerang Golf Club



Colour	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Santa Ana	6.2	3.0	5.0	2.7	2.3	2.3	0.3	1.5
Velvetene	3.0	3.5	3.8	0.0	1.0	0.7	0.3	0
Sea Isle 1	3.0	3.8	4.2	0.0	0.5	0.5	0.2	0
LSD (P=0.05)	0.3	0.7	0.9	0.7	1.2	0.9	0.8	

Table 6: Colour ratings of fairway plots at Kerang Golf Club

Discussion

Santa Ana has proved itself to be highly salt tolerant (see earlier trial work on salinity tolerance), and this is combined with excellent drought tolerance (and excellent quality and short dormancy, by the way). At this particular site the lack of irrigation killed off the two Paspalum varieties, regardless of their ability to tolerate salinity. The Santa Ana variety, while extremely stressed, survived with virtually a full cover of grass, and was by far the better solution for this site.

The results from Kerang and our other sites clearly demonstrates that the Paspalum varieties are reasonably drought resistant, but nowhere near as much as the Cynodon couches. If the Paspalums were needed at a particularly saline site (eg: very saline irrigation water or naturally saline soils), sufficient irrigation must be supplied to avoid excessive drought stress.

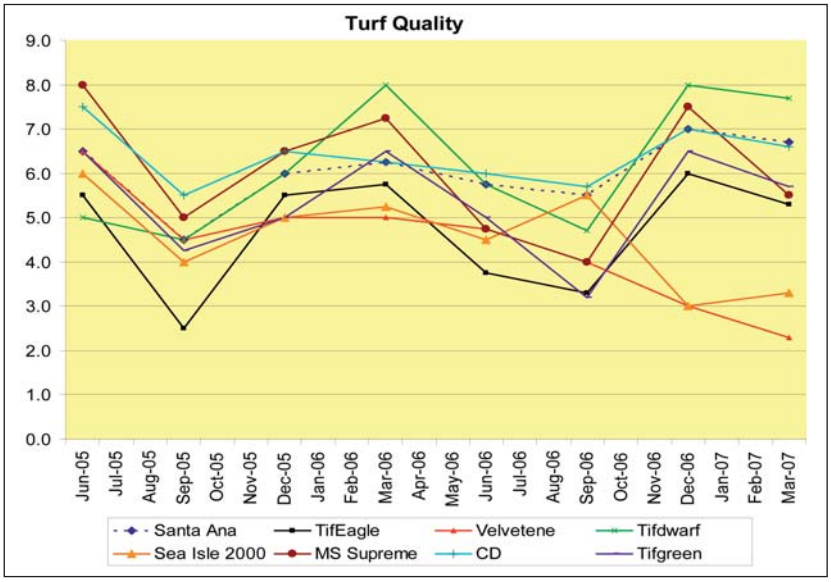
Work has been published, and more is underway, regarding the salinity tolerance of couchgrass varieties. It does appear that Santa Ana is extremely salt tolerant even for a Cynodon, and Victorian golf clubs with salinity problems should not ignore it when looking for a suitable species. More work needs to be done at saline sites to see whether the Paspalums do have a role in Victoria, but its lack of drought tolerance relative to Cynodon is a problem.

6. NMIT Fairfield site

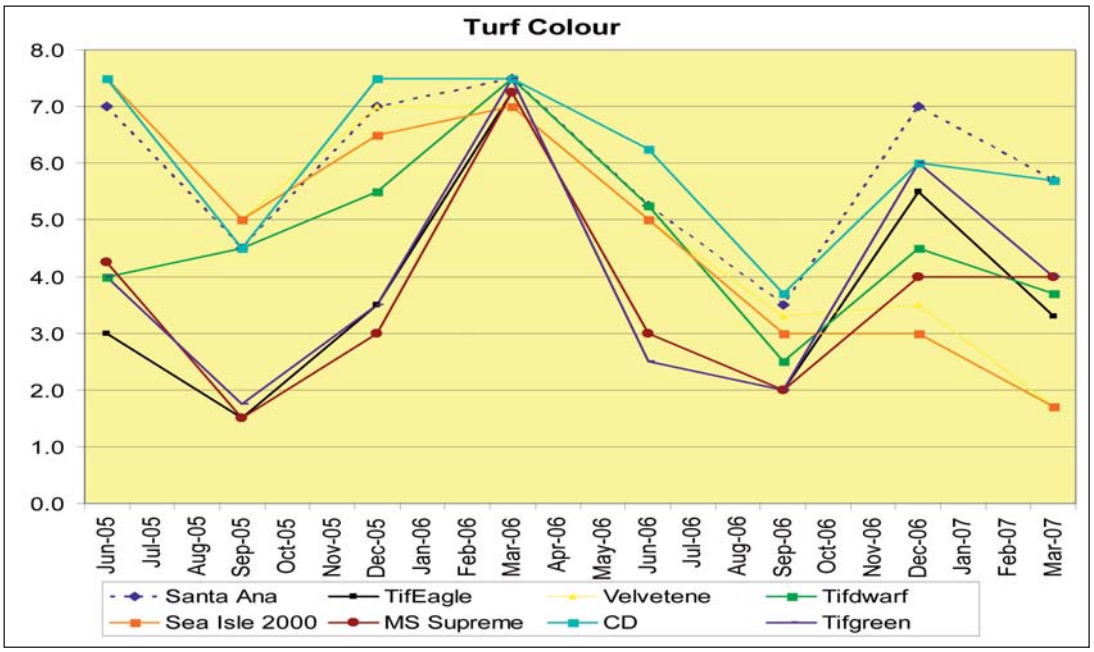
The Northern Melbourne Institute of TAFE Horticulture campus is located at the old Fairfield Infectious Diseases hospital and ran a set of plots looking at simulated greens conditions, with the exception of the final summer (06/07) when the plots were allowed to go into severe moisture stress. The results and discussion follows:

Quality	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Santa Ana	6.5	4.5	6.0[a]	6.3	5.8[a]	5.5[a]	7.0[a]	6.7[a]
TifEagle	5.5	2.5	5.5	5.8	3.8[a]	3.3	6.0	5.3
Velvetene	6.5	4.5	5.0	5.0	4.8[a]	4.0[a]	3.0	2.3
Tifdwarf	5.0	4.5	6.0[a]	8.0[a]	5.8[a]	4.7[a]	8.0[a]	7.7[a]
Sea Isle 2000	6.0	4.0	5.0	5.3	4.5[a]	5.5[a]	3.0	3.3
MS-Supreme	8.0[a]	5.0[a]	6.5[a]	7.3[a]	4.8[a]	4.0[a]	7.5[a]	5.5
CD	7.5[a]	5.5[a]	6.5[a]	6.3	6.0[a]	5.7[a]	7.0[a]	6.6[a]
Tifgreen	6.5	4.3	5.0	6.5	5.0[a]	3.2	6.5[a]	5.7
LSD (P=0.05)	1.3	0.6	0.8	1.2	2.2	1.8	1.5	1.8

Colour	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
Santa Ana	7.0	4.5	7.0	7.5	5.3	3.5	7.0	5.7
TifEagle	3.0	1.5	3.5	7.3	3.0	2.0	5.5	3.3
Velvetene	7.5	5.0	7.0	7.0	5.0	3.3	3.5	1.7
Tifdwarf	4.0	4.5	5.5	7.5	5.3	2.5	4.5	3.7
Sea Isle 2000	7.5	5.0	6.5	7.0	5.0	3.0	3.0	1.7
MS-Supreme	4.3	1.5	3.0	7.3	3.0	2.0	4.0	4.0
CD	7.5	4.5	7.5	7.5	6.3	3.7	6.0	5.7
Tifgreen	4.0	1.8	3.5	7.5	2.5	2.0	6.0	4.0
LSD (P=0.05)	1.0	0.3	0.7	0.4	3.7	1.2	1.2	1.5



MS-Supreme and CD were in the top group for quality on 7 out of the 8 assessments, and provided an excellent surface. The more traditional varieties Santa Ana and Tifdwarf were frequently in the top group, and also performed well. Both Paspalum varieties performed poorly under this management, which obviously didn't suit them (sand profile, low nitrogen, frequently droughted).



MS-Supreme, Tifgreen and TifEagle had the longest dormancy. This needs to be taken into consideration along with quality. Although MS-Supreme provided excellent quality, its long winter dormancy will not suit it to golf clubs with a lot of winter play. Bowling greens may be different, with mainly summer play, but golf greens are subjected to year round traffic.

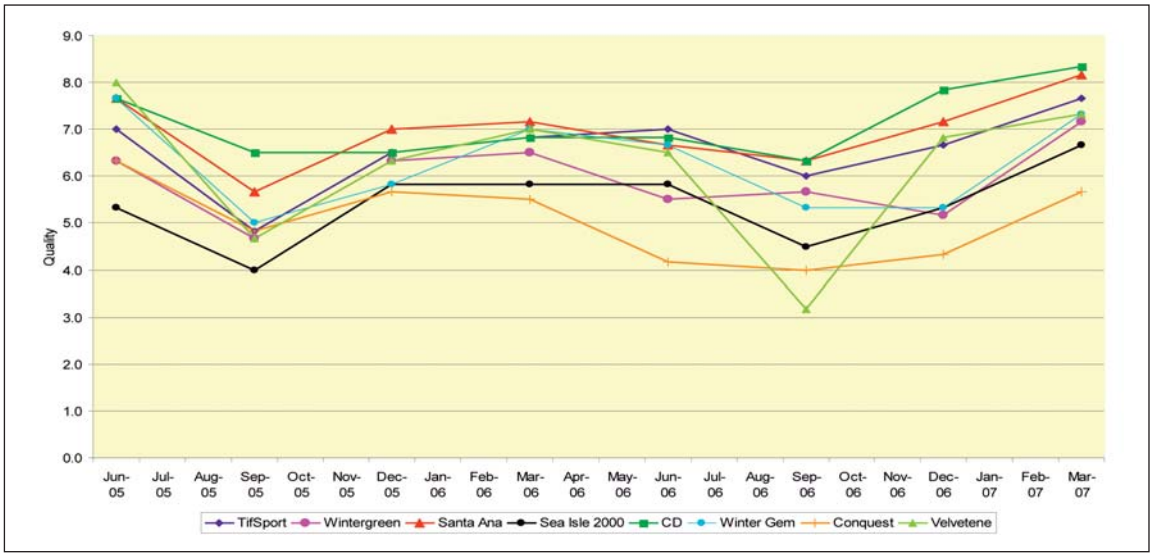
Discussion:

The variety CD combines consistently high quality and short winter dormancy, and as other sites in this project show, it has a lot of potential in the Victorian golf industry. It is finer than Santa Ana, and denser, although not as dense as the dwarf and ultradwarf varieties. Although it provides a consistently good surface, Santa Ana is just a little coarse textured to provide the elite quality that the dwarf or ultradwarf couches can provide in the warmer months. The dwarf and ultradwarf couch varieties currently available, however, have a long winter dormancy in our climate, and high susceptibility to Spring Dead Spot.

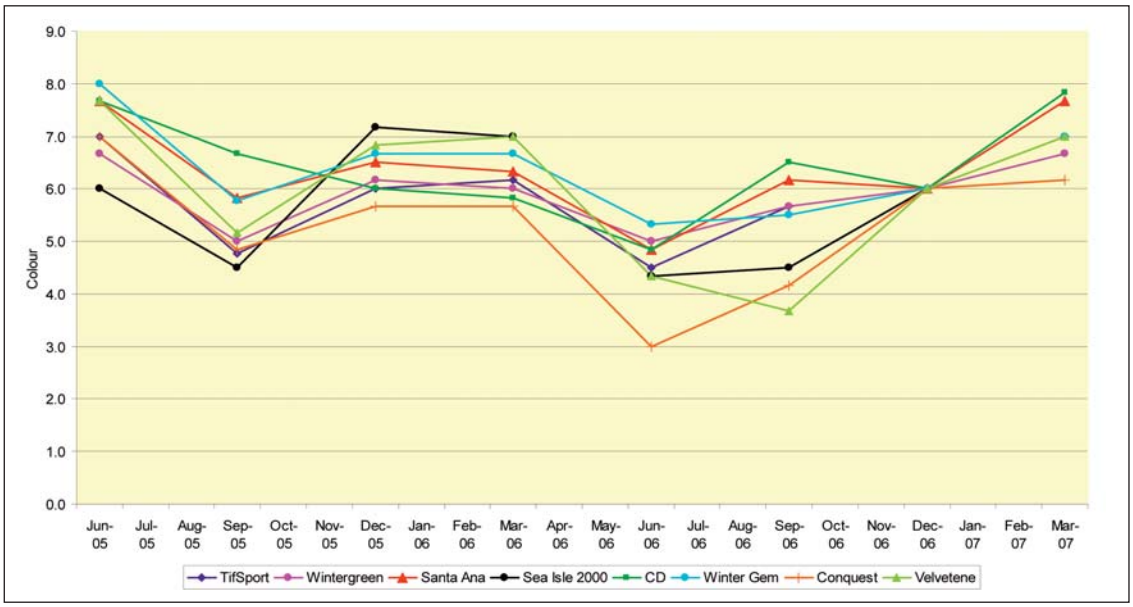
7. Riverside Golf Club:

The site at Riverside is maintained as a golf tee, with mowing height and level of inputs somewhere between a green and a fairway level. Three replicate plots of eight varieties were sown, with the results summarised and discussed below:

Quality	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
TifSport	7.0[a]	4.8	6.5[a]	6.8[a]	7.0[a]	6.0[a]	6.7[a]	7.7[a]
Wintergreen	6.3	4.7	6.3	6.5[a]	5.5	5.7[a]	5.2	7.2
Santa Ana	7.7[a]	5.7[a]	7.0[a]	7.2[a]	6.7[a]	6.3[a]	7.2[a]	8.2[a]
Sea Isle 2000	5.3	4.0	5.8	5.8	5.8	4.5	5.3	6.7
CD	7.7[a]	6.5[a]	6.5[a]	6.8[a]	6.8[a]	6.3[a]	7.8[a]	8.3[a]
Winter Gem	7.7[a]	5.0	5.8	7.0[a]	6.7[a]	5.3	5.3	7.3[a]
Conquest	6.3	4.8	5.7	5.5	4.2	4.0	4.3	5.7
Velvetene	8.0[a]	4.7	6.3	7.0[a]	6.5[a]	3.2	6.8[a]	7.3[a]
LSD (P=0.05)	1.1	1.4	0.5	1.2	0.8	0.7	1.4	1.0



Colour	Jun-05	Sep-05	Dec-05	Mar-06	Jun-06	Sep-06	Dec-06	Mar-07
TifSport	7.0[a]	4.8	6.0	6.2	4.5[a]	5.7	6	7.0
Wintergreen	6.7	5.0	6.2	6.0	5.0[a]	5.7	6	6.7
Santa Ana	7.7[a]	5.8[a]	6.5	6.3[a]	4.8[a]	6.2[a]	6	7.7[a]
Sea Isle 2000	6.0	4.5	7.2[a]	7.0[a]	4.3[a]	4.5	6	7.0
CD	7.7[a]	6.7[a]	6.0	5.8	4.8[a]	6.5[a]	6	7.8[a]
Winter Gem	8.0[a]	5.8[a]	6.7	6.7[a]	5.3[a]	5.5	6	7.0
Conquest	7.0[a]	4.8	5.7	5.7	3.0	4.2	6	6.2
Velvetene	7.7[a]	5.2	6.8[a]	7.0[a]	4.3[a]	3.7	6	7.0
LSD (P=0.05)	1.1	0.9	0.4	0.7	1.0	0.7	0	0.7



Discussion: Riverside GC plots

Santa Ana and CD were the standout varieties, ranking in the top group for quality on all eight assessments, and in the top group for colour each June and September, the key assessments for dormancy. TifSport also performed well, falling into the top group on 7 out of 8 assessments. Conquest and Sea Isle 2000 were the only two grasses never to rank in the top group for quality. Conquest is quite a coarse textured grass probably more suited to fairways and sports ovals, rather than a fine turf situation.

8. Patterson River

Three replicate plots of eight varieties were sown at this site in 2004. Unfortunately weed invasion (mainly a local couch strain not killed effectively before establishment) meant that assessments were meaningless after the first summer. The results of two assessments are shown. No conclusions regarding grass performance can be gained from this data. This site was irrigated with Class C effluent water, and there was some interest in which grass was more suited to this irrigation source. It is widely understood in the industry, however, that any of the grasses would handle the very moderate salinity found in this water. The main impact that effluent water has on these grasses is due to nutrient input rather than salinity.

Quality Ratings	Dec-05	Mar-06
Santa Ana	7.2^{a}	$5.8^{a,b}$
CD	7.5^{a}	$6.0^{a,b}$
TifSport	$7.0^{a,b}$	6.5^{a}
Winter Gem	7.3^{a}	$5.8^{a,b}$
Legend	$5.8^{a,b,c}$	$5.3^{b,c}$
Conquest	$5.3^{b,c}$	4.7^{c}
Princess	$5.5^{b,c}$	$5.5^{a,b,c}$
Wintergreen	7.2^{a}	$5.5^{a,b,c}$
LSD (P=0.05)	0.7	1.0

9. Gisborne Golf Club

Because of the loss of Patterson River as a site, and because of pressure to include a site with effluent water in the project, Gisborne Golf Club was selected as a replacement site. By this stage (summer 2006) it had become obvious that the couch variety CD had great potential, and because it is not grown commercially or available in any sort of quantity it was decided to devote the Gisborne site entirely to CD. An area of 400 square metres was established, and this will provide some sprig material for further field trials from December 2007 on.

Final Conclusions and Recommendations:

Grass performance will vary under different conditions (eg: climate, soil type, irrigation and nutrient inputs, mowing height etc). It is unwise to draw conclusions on a grass variety growing in different conditions from yours. Where possible localized trial plots are strongly recommended before embarking on a major grass conversion. Bearing this in mind, it is still possible to draw some important conclusions from the project:

1. Couch grass and its hybrid varieties are the superior fairway surface for golf courses in Victoria. They have a low irrigation requirement, excellent survival without irrigation and rapid recovery when rainfall or irrigation occurs.

2. Of the couch grass varieties available, Santa Ana is an excellent choice for fairways. It has been used in Victoria since 1980 and still rates as well or better than later varieties for quality, shortness of dormancy and winter colour retention, low disease susceptibility, drought resistance and salt tolerance.

3. Santa Ana has also worked well on greens, although its slightly coarse texture (in comparison with dwarf and ultradwarf varieties) sets an upper limit on its quality. Being a year-round game, a combination of good quality and short dormancy is required for greens, and Santa Ana can provide this, as evidenced by the good quality of the greens at Kialla Golf Club. Clubs are encouraged to stay informed of the progress of the Santa Ana greens at Kialla.

4. At this stage the variety CD looks very promising for greens (and fairways and tees), but supply will be extremely restricted for at least several years. The VGA is hoping to expand the production of CD and establish further trial sites over the next two summers. Clubs thinking of couchgrass greens are encouraged to contact the VGA Turf Board about setting up a trial site on a practice green or nursery.

This will serve three purposes – it will allow you to assess its performance in your own location, it will allow the Superintendent to become familiar with the management requirements of the grass, and it will provide sprigs for future planting.

5. The Paspalum vaginatum varieties tested have quite good drought resistance, but not in the same league as the Cynodon couchgrasses. There may be situations where the variety Sea Isle 2000 can provide a high quality surface, probably where soil salinity is extremely high, or where irrigation water is highly saline but in good supply. Our results indicate that Santa Ana, though, will probably do as good a job, or better if you factor in its lower water requirement. The Paspalums, though, appear resistant to Spring Dead Spot, and this may prove important over time.

6. The ultradwarf varieties MS-Supreme and TifEagle can provide elite greens quality at times (in the summer months), but have a long dormancy and are extremely susceptible to Spring Dead Spot. Results from this project indicate they are not well suited to Victorian conditions, especially for a yearround game. Tifdwarf remains the better option where a very fine, dwarf couch is required. We don't rule out their use, but if any of these dwarf or ultradwarf couches are used a very high standard of management will be required, including fungicide application as required for Spring Dead Spot control. The VGA Turf Board will continue to trial potential C_4 greens varieties from summer 2007 on.

Acknowledgements

The Victorian Golf Association Turf Research Board wishes to acknowledge the Smart Water Fund - an initiative of the Victorian water industry and the Victorian Government - for making this project possible. For further information on the Smart Water Fund please visit www.smartwater.com.au or Freecall 1800 882432.

We also wish to thank the host golf courses and their Superintendents (Metropolitan Golf Club, Kerang Golf Club, Riverside Golf Club, Patterson River Golf Club and Gisborne Golf Club) and the Turf Management teachers and students at Northern Melbourne Institute of TAFE. Also thanks to the turf team at Queensland Dept. Primary Industries, and to the turf companies that assisted, including Twin Views Turf (Qld) and Evergreen Turf (Pakenham).

Further Reading:

Ford, P. (2000): Victorian Golf Association Turf Research and Advisory Board report 'Low Input Fairway Grasses'. www.golfvic.org.au, follow links to Golf Services and Turf Management.

National Turf Evaluation Program (NTEP): www.ntep.org

Victorian Golf Association Turf Research Board