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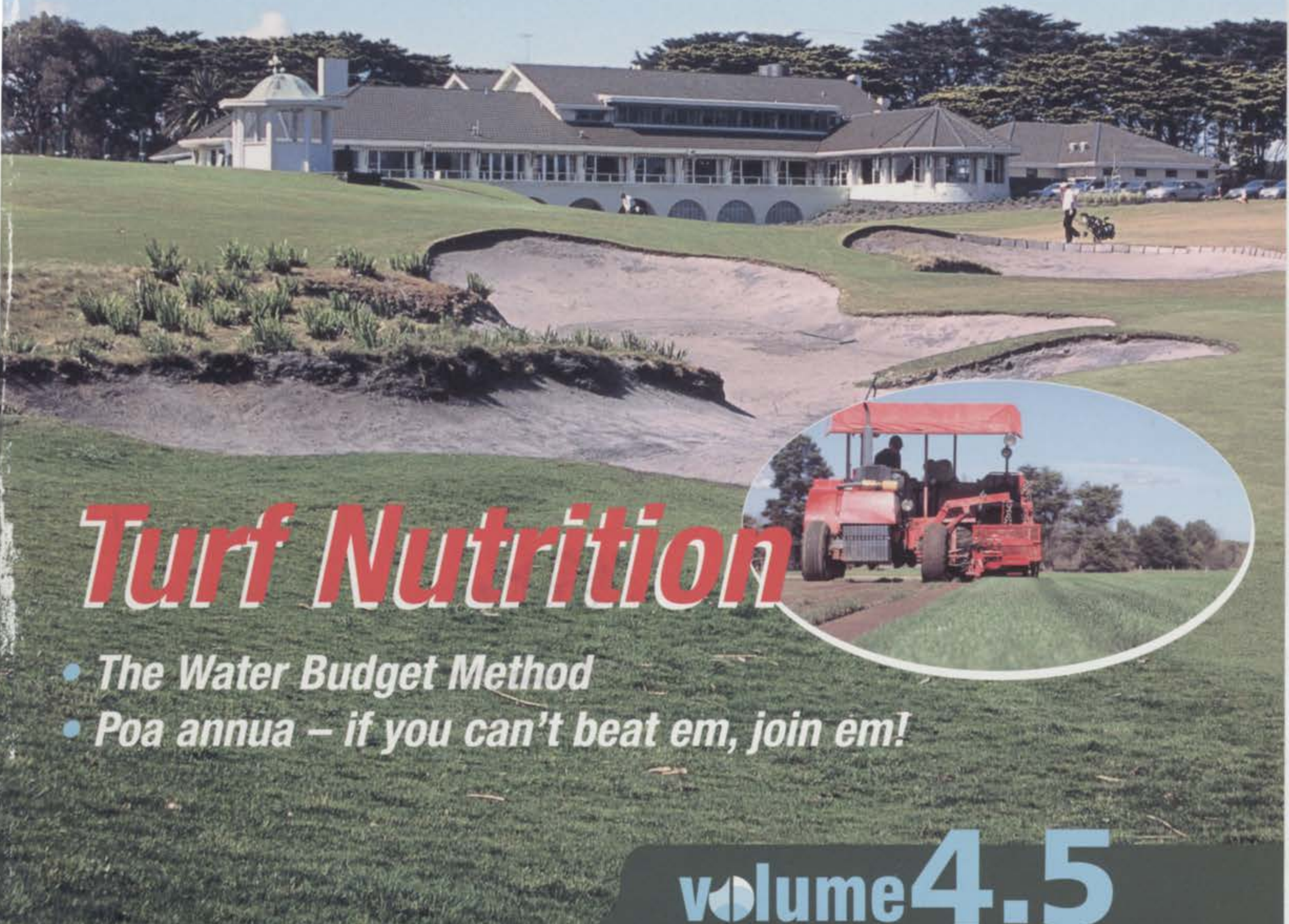
Turfgrass

MANAGEMENT

Victoria Golf Club

Hard and Hungry



Turf Nutrition

- The Water Budget Method
- Poa annua – if you can't beat em, join em!

volume 4.5
October - November 2002

John Deere *Salute*

"HORIZONS GOLF RESORT"

First hole

Horizons Golf Resort, located two hours north of Sydney at Salamander Bay, has been transformed from a wasteland to one of New South Wales best resort courses, thanks largely to the efforts of course superintendent Darren Watson and his staff.

To look at the course now, it is hard to believe that this land was once a wasteland and was even used as a sand mine for a period of time. This unique history, resulting in a site with a sub layer of sand, has proven to be both an advantage and a challenge to Darren and his staff. "We had to install one of the most advanced irrigation systems in Australia because we initially had trouble keeping moisture levels up during our hot summers," Watson explains. "The irrigation water drains through very quickly. But of course, that's an advantage when we get the heavy rains. The course can have eight inches of rain overnight and still be open for play the next morning".

Darren has been involved at Horizon's from day one as a member of the construction team responsible for developing the site and has been the superintendent for the last nine years. From the outset, it was apparent that the Horizons development has a strong commitment to nature and Darren and his crew continue to work hard to maintain the natural setting of the course. Each hole on the course is distinctive in its own right, with each designed to preserve as much of the natural surroundings as possible. A prime example of this commitment to nature is the boardwalk bridge from the 11th green to the 12th tee, which spans 200 metres across some of the wettest of the wetlands. "It's a walk through native bush and especially during the wet season, you can see some of the local wildlife including birds, koalas and kangaroos. It's one of the really special features of this course", Watson says.

As if looking after a golf course comprising of 30 hectares of fairways and rough, 1.8 hectares of tees and 1.7 hectares of greens was not enough, Darren and his crew are also responsible for maintaining the streetscapes and resort surrounds as well. This is no small feat, as the resort consists of accommodation ranging from residential houses, to condominiums and apartments as well as 2 swimming pools, tennis and volley ball courts, conference facilities and even a 5-star restaurant.

In order to maintain the golf course and resort to it's own high standards, Darren requires a high level of performance and commitment from not only his staff, but also from his maintenance equipment. "During the early stages of development we used different brands of equipment, but the course proved to be too much for them. When it was time to look at new machines, we evaluated a lot of equipment, tried a lot of models and really looked closely at who could provide the best service".

17th hole

In the end Darren selected a range of John Deere equipment from his local Golf & Turf dealer including surround mowers, spray units and Lightweight Fairway Mowers. "We run a small number of machines, so downtime is important. If you lose a machine that does a lot of different jobs, it's frustrating, but both John Deere and Sharpes Tractor Centre haven't let us down".

John Deere looks forward to continuing it's relationship with both Darren Watson and Horizons Golf Resort and congratulates Darren and his crew on the word class nature of the facilities they maintain.

JOHN DEERE

Gianni Ferrari

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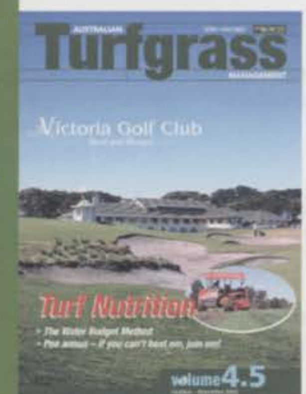
cover

Victoria Golf Club from behind the 18th green with club house in the background.
Photography, Phil George.



special features

research

in every edition

End of an Era!

As I am sure many of you will no doubt be aware, Euan Laird has resigned as Chief Executive Officer of the Australian Golf Course Superintendents Association (AGCSA).

Taking on the job almost 10 years ago as one man with a desk and a phone in the corner of the Australian Golf Union (AGU) offices, Euan leaves the association; recognized as the turf industries peak body, financially secure with a diverse income stream and portfolio of services and staffed by a highly qualified group of dedicated professionals.

Euan lists his greatest achievements as going some way towards raising the profile and professionalism of the turf management industry, earning the association respect within groups such as the AGU, PGA and Secretary Managers and staging the highly successful Millennium Turfgrass Conference that united the industry like never before. The establishment of AGCSA*Tech* and the 'industry owned' *Australian Turfgrass Management (ATM)* magazine are also highlights of a great career.

Before his departure in the middle of September, Euan expressed his appreciation for the outstanding contributions made by AGCSA Board members over the years and stressed that in his opinion the success of the AGCSA going forward, would as always rely on harnessing the support of members.

'Every cloud has a silver lining' and although Euan will be a great loss to the association, an opportunity now exists to inject some fresh ideas and open a new chapter in the life of the AGCSA that is sure to see us capitalize on the achievements of the past and break new ground in the key areas of member support, service and representation.

In this edition of *ATM* we visit the Victoria Golf Club, host of this years Holden Australian Open, David Huff, popular Turf Breeder from Penn State University makes observations on his recent travels through New Zealand and Australia and Kevin Handrek presents part 2 of his series on water budgeting.

In RESEARCH, we publish some outstanding work on gene flow from transgenic creeping bentgrass and feature articles on plant nutrition and ryegrass breeding.

All the best for spring.

Regards

Phil George
Editor

PHIL GEORGE
EDITOR

IAN CHIVERS
RACING SOLUTIONS

JOHN NEYLAN
AGCSA

LES BURDETT
S.A.C.A

WARREN WILLIAMS
DOOMBEN RACING CLUB

ROSS WARD
NOOSA HEADS BOWLS CLUB

President's Pen

For the AGCSA the coming month is now focussed on the aim of finding a replacement for Euan Laird, the AGCSA CEO for the past 9 and 1/2 years.

As I mentioned in my letter to all AGCSA members, the resignation of Euan came as a great shock to both the Board members and to the staff. We do, however, appreciate Euan's reasons and wish him well in his future endeavours.

It is also worth mentioning the role that Euan's wife Jacqui has played during his employment with the AGCSA and to that end I take this opportunity to thank her for her understanding and patience over the years.

The last Board meeting, held in August, also coincided with the need to review the 'Strategic Plan' of the Association for the next 5 years. Whilst the final plan is not likely to be formalised until the new CEO has taken up their position it can be said that the major focus of the Association will continue to relate to further development, member services and the recognition of the AGCSA as a peak industry body.

It was of interest to note that in relation to the previous Strategic Plan, set 5 yeras ago, that the Association had achieved more than 75% of its targets. This is due in no uncertain way to the management and staff of the Association, and through member support of the initiatives of the AGCSA.

Recently included in the Association Newsletter, was a Member survey form. If you have not taken the time to complete and send it back please do so as this greatly assists the Board and staff in the policies and direction that the Association takes, both in short and long term.

With the golfing/summer season coming up quite quickly I wish all Superintendents and Turf Managers a stress free time and hope that all the relevant God's are smiling on you and your facilities.

Of course, do not forget that the AGCSA will once again be providing Course Quality Officials (CQO's) for the Australian Open in November.

Until then, enjoy the magazine.
Yours in Golf

Mark K. Couchman
President AGCSA
Superintendent Tewantin-Noosa GC.

Mark Couchman, AGCSA President

Evolutionary Role of Hybridization

TECHTALK

ANDREW PEART

Andrew Peart: Technical Officer

Natural selection through the adaption of grass species to environmental conditions and other stresses has enabled many different types of the one species to evolve over time. Plant breeders use this diversity within a species to develop new cultivars and varieties. However, the use of hybridization or making crosses between species within a genus or between genus's, can allow for greater genetic diversity within the turfgrass plant, thus introducing attributes that would normally not be associated with a particular species.

Hybridization between two grass species, followed by chromosome doubling and a return to fertility has long been recognized as one of the key evolutionary processes in grasses. Natural or chance hybridizations have been reported by taxonomists but rarely utilized by breeders. Controlled hybridization between two grass species may increase the genetic variability available to turf grass breeders to select for unique cultivars.

In many hybrids the resulting plants are male and female sterile. However, fertility in interspecific and intergeneric hybrids has been achieved through chromosome doubling by the use of chemicals such as colchicine to inhibit spindle formation during mitosis.

In nature, polyploid cells occur due to a "mistake" of mitosis where the chromosomes divide but the cell does not. Thus a cell with twice the usual number of chromosomes is produced. If these cells then go through interphase and divide they can give rise to a new individual with twice the number of chromosomes than its parents or parent. They may also occur from the union of unreduced gametes – eggs and sperm that have not undergone normal meiosis and still have a 2n constitution.

If a 2n egg from one species is fertilised by the n pollen of another species, a triploid hybrid results. Then, if the triploid produces a 2n egg and is fertilized by a 2n pollen from the same plant, an allopolyploid results. Many other combinations may lead to fertile allopolyploids depending on the ploidy level of the egg and pollen plant and formation of unreduced gametes.

COOL SEASON TURFGRASS SPECIES

Hybrids between perennial ryegrass and annual ryegrass (L.perenne & L. multiflorum) are known as intermediate ryegrasses and are becoming increasingly used in the overseeding market due to their dark green colour and their transitional qualities.

Hybrids between *Lolium* and *Festuca* species has recently been of more interest to turf grass breeders. The fescues are often more tolerant of environmental stresses such as drought and heat, while the ryegrasses have better growth characteristics over the winter months. Hybrids have been found to be easily created with fertility restored through chromosome doubling. However, instability (i.e high tendency to produce "off-types") and sterility have resulted in later generations.

WARM SEASON GRASSES

Perhaps the best known example of interspecific hybrids in turfgrass are the hybrid couches. These hybrids are sterile triploids from the cross of diploid *Cynodon transvalensis* and tetraploid *Cynodon dactylon*. As these hybrids are readily propagated vegetatively, sterility does not pose a problem and the reduced chance of seed production improves variety stability and purity.

The hybrid cultivar 'Tifgreen' was officially released in1956, followed by 'Tifway' in 1960. Clonal off-types were discovered in 'Tifgreen' and they were presumed to have arisen as spontaneous mutations. One of these "off-types" was selected as a cultivar named 'Tifdwarf', released in 1965. However, due to the rare nature of mutation events it may have simply been contamination within the original planting stock, even though mutations ultimately may have been involved.

The use of non-ionizing radiation eg. gamma rays has been used to create artificial mutations in an attempt to create genetic variability amongst quality cultivars. 'Tifeagle', released in the late 1990's is one such cultivar derived from irradiating stolons of 'Tifway 2', that in turn was released in 1981 after 'Tifton' couchgrass cultivars had been irradiated. 'Tifeagle' is much finer than 'Tifway 2' and produces higher quality turf at mowing heights down to 2.5mm. It can offer superintendents an alternative to 'Tifgreen' or 'Tifdwarf'.

There is always room for improvement and hybrids in the future will be genetically different to those currently on the market. Research projects to date indicate that the new hybrids can produce quality turf with fewer inputs than required by current cultivars.

Breeding Ryegrasses for Australia

Despite the fact that there are numerous temperate species offering significant potential as turf types in Australia, New Zealand and North America, the majority of temperate species used as turf in Australia has evolved in Europe.

Taking turf type ryegrass as an example, this is not so hard to understand. Ryegrass has a history of spreading with man, his crops and his grazing animals. It had the ability to establish rapidly in stock camps where fertility was high, moisture abundant and grazing and trampling were often severe. Conditions not too different from a wet winter sportsfield.

However, it is not just a matter of introducing grasses from anywhere in Europe. Within Europe the climate varies and everyone knows that the north has a cold winter with a mild moist summer, while the southern parts including the Mediterranean have a long dry summer with a mild moist winter. The plants from each region have adapted their growth rhythm to match. Each form is superbly adapted to its conditions and often equally poorly adapted to the opposite conditions so that when we plant a northern grass in the Mediterranean it will not tolerate the drought and a Mediterranean plant would not survive the winter in the north of Europe.

The southern regions of Australia have a Mediterranean climate and of course germplasm from the Mediterranean and Southern Europe has superior adaptation to these parts of Australia than Northern European material, with superior growth in cool temperatures.

Understanding this simple principal has become a key point in breeding grasses for Australia. The English grasses brought here by the early settlers were not well suited to the Mediterranean climate. This was recognised by plant scientists and seed was actively sought from the Mediterranean regions. These collecting expeditions of the 1950s resulted in many new pasture plants but turf grasses were not a focus at this time.

Winter active turf plants - Winter dormant turf plants

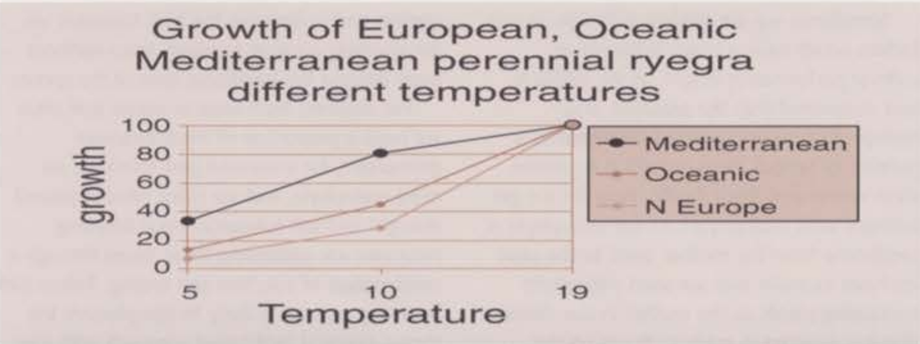
In recent years plant breeders have collected from these regions for Australia and crossed these with the finest, most dense turf types from North America and Europe. This has resulted in improved winter growing plants adapted to Australia with a greater ability to recover from winter wear.

How do we breed a turf variety?

Basically, we plant out a large number of plants and from these we select what we consider to be the most suitable types. This may involve many measurements and observations over a number of years. The few selected plants are then crossed together to form an experimental variety and from these, seed is harvested from an area free of other ryegrass. This seed is grown in isolation from other ryegrass pollen to prevent contaminating the cross. This and many other experimental varieties are then tested for their performance under realistic turf conditions.

The question facing a plant breeder is which populations of plants should he/she use to select from. Should he/she use material collected in old turf areas and sportsfields, the best new cultivars, new germplasm collected in the wild or various combinations and crosses of these. Clearly, the answer depends on the objective and each has limitations.

Collection sites for Mediterranean germplasm



Relative growth at different temperatures of ryegrass germplasm collected in different climate zones of Europe, with that from Mediterranean regions having more growth than that from Oceanic regions, and that having more than those from Continental regions. This work was part of the classical ecological studies carried out in the UK by Cooper in the 1960's

Material collected from old turf areas and sportsfields can be valuable but suffers from the limitation that this was probably planted in old pasture types or at least with a limited range of types so will lack diversity. However, this problem can be managed by collecting widely and selecting from old trials. Plant breeders have developed a large range of fine and dense types from what were in effect coarse types 30 to 40 years ago.

Selecting from within a range of the better performing cultivars is also valuable, but suffers from the limitation that eventually we will end up with a very a narrow range of plant material with little genetic diversity left for future selection. To solve this problem we must cross with different plant material.

New germplasm collected in the wild is valuable because it can introduce many new genes for a range of factors such as improved disease resistance. However, much wild material is coarse and light coloured and poorly adapted to our conditions and will require crossing with good turf cultivars before we can begin to select.

In reality, we have to use all these approaches to make sure we improve cultivars, selecting and crossing among the best cultivars, plants collected from old turf areas and new germplasm collected in the wild obtained from genebanks.

Genebanks are collections of seed from material collected on numerous expeditions. Dr. Reed Funk of Rutgers University, USA first described the shortage of different parent material within the turf ryegrass genepool in the 1980's. Since that time any number of collection missions have been undertaken by Universities and private breeders in the USA to collect a wider range of germplasm. Much of this has involved selection from areas described as Mediterranean.

One excellent example of the material that is now available is the Margot Forde Germplasm Centre at Palmerston North, New Zealand. It is the official repository for perennial temperate grasses in Australia and New Zealand and holds over 60,000 seedlines stored under refrigerated dehumidified conditions. A core collection is regenerated every 30 years or so to ensure that it is available in perpetuity. Breeding companies have their own working collections. The New Zealand breeding companies and AgResearch have recently funded programs to collect germplasm in the west coast of the USA and Turkey which has resulted in some new and unique material.

New germplasm sources can sometimes provide new and valuable features for turf. For example the collection and breeding of rhizomatous tall fescue cultivars allows the turf to knit together providing greater stability in sand fields.

Rhizomes in turf tall fescue

Survival of turf germplasm under drought

Effect of endophyte on turf recovery from summer drought

The process of breeding a cultivar takes from 5 to 15 years and even then the cultivar must be maintained true to type and never change. The cost of breeding each cultivar varies but it would not be unusual for a cultivar to cost $100,000 to breed. Seed production is carefully monitored by the company and seed certification authorities to ensure contamination does not occur. The Mediterranean climate of Australia favours many annual weeds and grasses such as annual ryegrass so contamination can be a problem, however, there has been a significant increase in the amount of turf ryegrass breeding and evaluation that is occurring in southern Australia. Many companies are working with ryegrasses and the Seed Industry Association of Australia (SIA) have recently completed and evaluation of some 56 ryegrass varieties at two sites in Victoria.

Sometimes we are dealing with non-genetic factors which have a major influence on cultivar performance in turf. In the 1980s it was discovered that the presence of an endophyte fungus conferred resistance to a number of serious pests including Argentine stem weevil and Black Beetle. How do we get cultivars with endophyte? As the endophyte is seedborne from the mother plant to the seed we have to make sure we used endophyte containing plants as the mother in our crosses. This has resulted in many cultivars on the market today with the protection against certain pests that endophyte confers.

Australia faces large water shortages and issues of poor quality water with high salinity. Breeding to enhance the salt tolerance of turf ryegrass is now underway. This is carried out by selecting the few plants which will germinate in normal seawater at 32000 ppm and which survive as plants in 16000ppm. At these high concentrations less than 1 plant in 10,000 is selected. This is repeated for a number of generations to provide cultivars with enhanced salinity tolerance.

To increase wear tolerance breeders are selecting survivors from well worn sportsfields and from trials subject to extreme wear. This is resulting in plants more tolerant of wear and with an increased capacity to recover.

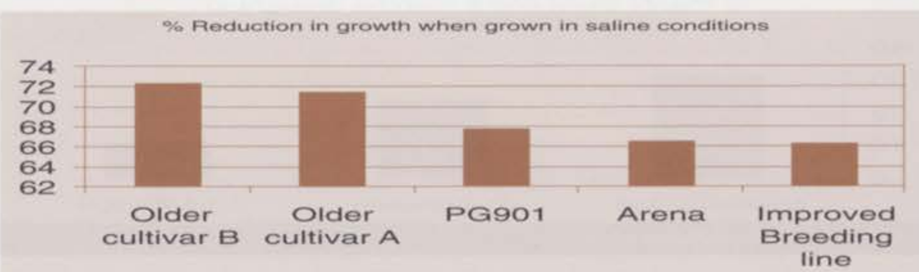
To increase drought tolerance we are selecting and crossing survivors from those few turf plants which survive the summers in dry regions and to improve the heat tolerance we are selecting summer survivors from northern areas beyond the traditional zone of the species.

For recovery from wear in winter turf areas we need a proportion of Mediterranean germplasm, for enhanced pest tolerance we need endophyte, and we often need improved drought and salt tolerance. Local breeding programs are addressing these issues through a combination of selection and testing. Future turf breeding research is likely to complement the strong practical field based approach with new biotechnology techniques.

Dr Alan Stewart is the Director of Research for PGG Seeds Research in New Zealand.

Winter wear damage in trials

Wear recovery in spring



Reduction of growth of turf selections grown in saline conditions

Hard and Hungry

Ian Todd, Golf Course Superintendent

Green side bunker, 3rd hole Victoria Golf Club

Located in the heart of one of the most famous golfing regions in the world, the Victoria Golf Club offers the genuine 'sand-belt experience' and is committed to retaining the heritage of golf. In November this year, the historic club will play host to the 2002 Holden Australian Open.

Beginning his career as an apprentice under Stan Ferguson at the Commonwealth Golf Club in the early 1980's, Golf Course Superintendent Ian Todd went on to spent 11 years at Woodlands Golf Club under John Sloan before taking up the top job at Victoria just on seven years ago.

Ian credits John for his own passion and enthusiasm for golf course management and describes John as the greatest teacher he has ever known. Not surprisingly, Ian shares a very similar philosophy to his teacher and labels his management style as "minimalist".

Ian said, "we have virtually no preventative programs in place at all. Pests and diseases are treated chemically only when it is absolutely necessary and the turf is fertilised on a needs basis. We like to let Mother Nature take her course and I honestly believe that the turf performs better because of it."

"I very rarely do soil testing either, I find it dulls my senses and prevents me for knowing my turf as well as I need to".

Like most championship courses, Victoria has undergone a number of changes over the last decade to stay relevant to the long-hitting modern game and have used Michael Clayton

Golf Designs to guide them through this challenging period. Mike shares the same passion and respect for golf as Ian and his management team and the association appears to be working well.

The bunkers at Victoria are what gives this course its 'teeth'. Numerous bunkers have been realigned and indeed new ones have been added but more significantly, the tees on holes 5, 9 and 18 have been pushed back to lengthen the holes and bring the original bunkers back into play. Many other tees have been extended by just a few meters to make sure that the course plays to its full 6,219m. By the clubs own admission I am sure, the first hole (233m par 4) has always been - well, perplexing, but changes to this green and the second tee complex are scheduled for after the Open.

Late in the summer if 1995 all the native couch fairways were over sprigged with Santa ana couch using a sprigging machine borrowed from Cranbourne Golf Club. At that time the native couch was poor in most areas and patching in the others but the Santa ana has done very well and now dominates all fairways. The Santa ana is a much denser grass than was the native couch and has made the course play a little shorter which has to be a concern for a course now strangled by housing. I have always noticed that the couch fairways at Victoria were at least a couple of weeks slower 'out of the blocks' than her sand-belt sisters in spring but to borrow parlance from the rag trade, 'brown is the new green'!

This 1936 photograph is being used to help restore the course's true character

Fairways, tees and the 'push-up' greens are all fertilised on a 'needs basis' which means usually once a year for fairways and not much more than that for tees and greens. Ian desires to keep the fairways "hard and hungry" and feels that he has a much greater chance of leading a 'successful co-existence' with *Poa annua* if his bentgrass is hungry. No one seems to know what type of bent exists on the greens but apart from the 1st and 17th that had been reconstructed and sown with penncross, the greens best approximate the 'Suttons Mix' that is being successfully reintroduced over the road at Royal Melbourne.

During the winter months the fairways are mown just a couple of times to clean up the divots but during summer they are cut twice per week. During the Australian Open they will be cut daily which means their two Toro 6500-D fairway mowers will be kept busy around the clock.

At 10mm, the fairway cutting height for this years tournament is quite a deal more generous than at Kingston Heath two years ago but then again Kingston Heath is about 200m longer.

Depending on the weather at the time and their general health, the greens will be cut at 2 – 2.5mm with walk behind mowers and Ian hopes to have them rolling about 12 feet from the stimp meter.

The Australian Golf Union (AGU) have spared Ian and his staff the worry of needing to produce 6 inches of rough by November, in fact the tournaments governing bodies have largely allowed the club to 'run their own race'. Not surprising I guess when you consider that Ian and his staff have been involved in preparations for six Victorian Opens and one Australian PGA event.

Ian is doing his best to keep a lid on things for as long as possible but his staff of 14 will grow to 30 (many former employees have already asked to return for the event) two weeks out from the event and from there it will be 'action all stations'.

We wish them all the best for what is sure to be a fantastic event and career highlight for those involved.

Extensive landscaping around the club house will have Victoria looking a picture for the Open


YOUR ESSENTIAL SUMMER SURVIVAL KIT.
SUN SCREEN

GENE FLOW FROM TRANSGENIC CREEPING BENTGRASS *(Agrostis stolonifera L.)* IN THE WILLAMETTE VALLEY, OREGON

research


bagging of inflorescences in bentgrass transects

ABSTRACT

Since the Willamette Valley produces nearly all of the bentgrass *(Agrostis spp.)* seed grown in the United States and exports bentgrass seed in large quantities to Europe, risks associated with the commercial production of transgenic cultivars in the major grass seed production area of the world must be defined.

Creeping bentgrass *(Agrostis stolonifera L.)* can be a serious weed in other crops. Since creeping bentgrass may be the first perennial, wind pollinated, outcrossing, transgenic grass species to be produced commercially, essential data must be generated on pollen movement within the crop.

Pollen flow, viability, pollination and seed formation are all sensitive to climatic parameters, which differ greatly from region to region, so it is imperative that this research be conducted where the crop will be commercially cultivated. The two primary objectives of this study were to investigate intra- and interspecific gene flow of transgenic creeping bentgrass in the Willamette Valley of Oregon. Pollen movement was determined by placing transects of non-transgenic creeping bentgrass around a nursery of 286 transgenic plants genetically engineered for tolerance to the herbicide glufosinate. Approximately 250 non-transgenic creeping bentgrass plants were planted in transects around the transgenic nursery in 1998 and 1999 near Hubbard, OR.

In 1998, the following transects were established: 1) two circles around the nursery at 109 (33.2 m) and 272.5 ft (83.1 m) with plants spaced at 50 ft (15.24 m) and 100 ft (30.48 m), respectively; and 2) two line transects aligned with prevailing winds (NE) with one transect NE 244 ft (74.4 m) and the SW transect 370 ft (112.8 m) from the edge of the nursery based on Oregon Seed Certification isolation distances, which is 165-300 ft (50.3-91.4 m) (depending upon field size) for certified seed production.

In 1999, the length of the line transects were increased to the following: 1) SW transect, 978 ft (298.1 m); 2) NE transect, 268 ft (81.7 m); 3) SE transect, 612 ft (186.5 m); and 5) NW transect, 319 ft (97.2 m). Using non-linear regression, the following distances were predicted for transgenic pollen introgression to the 0.02% level. In 1998, along the SW transect, transgenic pollen traveled 3,500 ft (1,066.8 m) and along the NE transect it traveled 4,296 ft (1,309.4 m). In 1999, the transgenic pollen was estimated to have traveled 1,022 ft (331.5 m) to the SW, 1,892 ft (576.7 m) to the NE, 861 ft (262.4 m) to the NW, and 1,022 ft (331.5 m) to the SE. The second part of the study was to evaluate interspecific hybridization in creeping bentgrass for its propensity to hybridize freely. Twelve species of bentgrass have been documented as occurring in the area of bentgrass seed production. Six are naturalized species and are part of a complex that freely hybridize: *A. canina* L., *A. capillaris* L., *A. castellana* Boiss. & Reuter, *A. gigantea* Roth, *A. stolonifera*, and *A. vinealis* Schreber. Accessions of *A. canina*, *A. capillaris*, *A. castellana*, *A. curtissii*, *A. gigantea*, *A. pallens*, and *A.* sp. were placed in the transgenic nursery prior to flowering and allowed to interpollinate. The crossing experiments resulted in the introgression of the bar gene from creeping bentgrass into *A. canina*, *A. capillaris*, *A. castellana*, *A. gigantea*, *A. pallens*, and *A.* sp. These data will be available to USDA-APHIS for use in creating a risk assessment model for commercial transgenic grass seed production.

INTRODUCTION

The importance and value of turfgrass is accelerating, due to its association with an ever-increasing urban population. In the United States alone there are over 14,000 golf courses, 40,000 athletic facilities, and 40 million home lawns and parks (Edminster 2000). This importance can also be seen in the size of the turfgrass seed market, which is only second to that of hybrid seed corn (Lee, 1996), with annual sales between $580 million – 1.2 billion. Although turfgrass management and production is one of the fastest growing areas of agriculture, genetic transformation of turfgrasses lags behind that of many other important crop plants (Johnson and Riordan 1999). Though conventional plant breeding can incorporate individual and multiple stress tolerance, as well as, agronomic traits, there are biological limits to how far a species can be manipulated by traditional plant breeding methods and progress can be extremely slow, costly, and sometimes impossible. DNA biotechnology can provide new, efficient, and innovative methods for the incorporation of not only individual, but also complex, multiple abiotic and biotic stress tolerances (Dale 1993; Lee 1996; Brilman 1997;

Duncan and Carrow 1999) that would be extremely difficult, if not impossible using classical plant breeding methods.

DNA biotechnological enhancement is being considered for virtually all commercially important plants and the number of field tests for transgenic plants is increasing exponentially. Many of the applications of DNA engineering in agriculture will probably have neutral or even beneficial environmental consequences, but commercial-scale production of some of these transgenic plants could lead to undesirable environmental and agricultural consequences

Plants such as turf, forages, rangeland, and bioremediation grasses that have undergone little domestication and often have wild relatives growing in sympatry (Arriola and Ellstrand 1996; Giddings et al. 1997a; Ellstrand and Hoffman 1990) and/or can be weeds outside of cultivation and in other crops, are particularly at risk of spreading transgenic DNA. Bermuda grass [*Cynodon dactylon* (L.) C. Persoon] is an important perennial forage and turfgrass, but it is also, in many areas of the United States, is one of the worst weeds. If a gene that would confer a selective advantage were introduced into a cultivar (by either biotechnology or conventional breeding) and the gene escaped into the weedy populations, the immediate economic and ecological impact could be significant (Ellstrand and Hoffman 1990).

The concern regarding the transfer of alien genes into local populations that results in non-weedy populations becoming weedy or weedy populations becoming more weedy is not the only issue. The other ecological impact could be the contamination of the native gene pool, which could have a variety of possible consequences (Kareiva et al. 1994). For example, the extinction of wild rice in Taiwan has been attributed in part to gene flow from cultivated rice to wild rice (Kiang et al. 1979; Oka 1992). So, the full impact of gene escapement on natural populations must be considered.

Since many of these problems begin with gene escape through the pollen, the logical first step in a biotechnology risk assessment is the quantifications of pollen movement and the intraspecific, interspecific and intergeneric hybridization possibilities between transgenic crops and non-transgenic populations. If pollen is found to travel great distances, pollen viability becomes an issue, and determining how far viable pollen travels under various environmental conditions must be assessed.

Creeping bentgrass has the potential to be the first perennial (stoloniferous), wind pollinated, outcrossing transgenic crop to be grown adjacent to naturalized and native populations of cross-compatible perennial relatives and native species. These are traits that can increase the risk of outcrossing, persistence, and introgression of alien genes into an adjacent population. However, the bulk of most of the risk assessment work conducted on transgenic plants has been on annual and/or self-pollinating crops. The potential risks from the commercialization and large-scale seed production of these types of transgenic crops is unknown.

The objectives of this research were to study:

1) intra-specific gene movement; and

2) interspecific gene introgression and stability of the hybrids.

The use of transgenic plants offers a unique opportunity to test and quantify pollen movement distances for creeping bentgrass using a dominant marker system.

MATERIALS AND METHODS

Transgenic Creeping Bentgrass

The transgenic plants that were used in this study were transformed by microprojectile bombardment at Michigan State University, by Dr. C.-A. Lu (1996) in Dr. Mariam Stricklen's lab.

Non-transgenic Creeping Bentgrass

The non-transgenic creeping bentgrass cultivar used in this study was Penn A-1. This cultivar was chosen because the plants were similar in age and maturity to the transgenic plants. Creeping bentgrass has a maturation requirement to reach optimum flower production and must be vernalized. Generally plants begin flowering their second year after vernalization. The plants were taken from a two year old production field (planted in 1997), which was the same age of the transgenic plants. The field was 4 mi south of the study site. New plants for the transects were dug each year for the study.

Experimental Design Of Transects for Infra-specific Gene Flow

Approximately 250 non-transgenic bentgrasses were planted in transects around the 286 transgenic bentgrass plants [36 x 128 ft nursery (ª 0.1 ac or 0.04 ha)] in 1998 and 1999. This ratio of transgenic to non-transgenic plants was sufficient to detect the spread of the bar gene. Gliddon (1999) pointed out that the vast majority of pollen dispersal studies involving marker genes have the transgenic organism as a small minority of the total organisms in the design, making it difficult to detect the spread of the marker gene in relation to the probability of recovering the non-marked gene. If the marker is represented by 1% of the total organisms, even if its spread is uniform across the entire experimental area, it will only be recovered in 1% of samples. "This fault of experimental design could well account for the very small distances that have been reported for the spread of GMO's (e.g. Scheffler et al., 1993)" (Gliddon 1997).

In 1998, the following transects were established (Figure 1): 1) two circles around the nursery at 109 (33.2 m) and 272.5 ft (83.1 m) with plants spaced at 50 ft (15.24 m) and 100 ft (30.48 m), respectively; and 2) two line transects aligned with prevailing winds (NE) with one transect NE and the SW of the transgenic nursery. The NE transect extended 244 ft (74.4 m) from the NE edge of the nursery and the SW transect extended 300 ft (91.4 m) from the SW edge of the nursery. Plants in the line transects were spaced 10 ft (3.048 m) apart for the first 120 ft (36.6 m), then spaced 20 ft (6.1 m) after. The initial length of the transects was based on Oregon Seed Certification isolation distances, which is 165 to 300 ft (50.3-91.4 m) (depending on field size) for certified seed production. To test the effectiveness of cereal rye (*Secale cereale* L.) as a pollen barrier, non-transgenic plants were planted around the inside of the transgenic nursery, six feet (1.8 m) inside the cereal rye, on the outside of the cereal rye border, and through the NE and SW corners of the cereal rye. One hundred sixty-eight plants were placed in or around the cereal rye border.

In the 1999 the experimental design was similar to that of 1998 with the exception of the following (Figure 2): 1) two additional line transects (SE and NW), orthogonal to the prevailing winds were added; 2) the length of the line transects were increased, where possible, to the following: a.) SW transect, 978 ft (298.1 m); b.) NE transect, 268 ft (81.7 m); c.) SE transect, 612 ft (186.5 m); and d.) NW transect, 319 ft (97.2 m).

Non-transgenic were also planted around the transgenic nursery both years; 3) Plants in the line transects were spaced 20 ft (6.1 m) apart for the first 300 ft (91.4 m) and then every 10 ft (3.048 m) apart after; 4) the plants in the 272.5 ft (83.1 m) radius transect were spaced every 50 ft (15.24 m), not 100 ft as in the previous year; 5) only 20 non-transgenic plants were planted around the outside of the transgenic nursery – 5 plants on each side; and 6) Row 10, the non-transgenic row of plants in the transgenic nursery, was the only non-transgenic plants in the nursery.

Non-transgenic plants were planted into the transects during February and March of each year. Once the plants finished flowering, inflorescences were enclosed in hybridization bags. Any remaining, unbagged, inflorescences were cut and burned to prevent any contamination. The inflorescences were then harvested and the non-transgenic plants were killed with herbicide (Roundup®) and then burned; they were replanted each year. The removal of non-transgenic plant prevented the contamination of this plant from any transgenic seed that may have been produced, fallen to the ground, germinated and grew in with the non-transgenic plant. If this occurred, then this plant would be producing transgenic pollen along the transect.

The harvested inflorescences were dried in the greenhouse. Once dry, seeds from each non-transgenic plant were planted and screened in greenhouse for herbicide resistance; 1000+ seeds were planted in order to get 1,000 seedlings to be screened. The seedlings were sprayed 2 to 3 times with Finale™ or Rely® (which has now replaced Finale™) once they reached the 3 to 4 leaf stage, with a rate of 5.7 L/.4 ha (6 qts/ac). This rate is listed for plants 8 in or taller. Screening seedlings with the high labelled rate of glufosinate [5.7 L/.4 ha (6 qts/ac) for Finale™] will sufficiently kill the plants and only those plants with the functioning bar gene can survive that rate, even though a low level of resistance to glufosinate is sometimes seen.

The number of survivors and the number of dead were counted. A sample of the survivors were sent to a biotechnology lab to confirm the presence of the bar gene using PCR and Southern Blot analysis. Once the percentage of resistant to non-resistant seedlings was determined, the data were then analyzed with Graphpad Prism® non-linear regression software. The curve that best fit the data was a 'Top to Zero One Phase Exponential Decay' Model. This allowed for the prediction of the percent recovery of the transgene over distance.

Inter-specific Gene Flow

Plants were placed in the transgenic nursery next to plants with a similar phenology. Accessions of *A. canina, A. capillaris, A. castellana, A. curtissii, A. gigantea*, in 1998, and *A. pallens* in 1999, were planted in the transgenic nursery prior to flowering and allowed to interpollinate. Seed was collected from these accessions, planted, and screened for herbicide resistance as described above.

RESULTS AND DISCUSSION

Intra-Specific Gene Flow

In 1998, >0.02 % transgenic plants were recovered at the ends of both the NE (74.4 m) and SW (91.4 m) transects, as well as, from most of the points along the circle transects (Figure 3). In 1999, >0.02 % transgenic plants were recovered at the following distances: 1) NE transect, 268 ft (end of transect); 2) SW transect, 958 ft; 3) NW transect, 319 ft; and 4) SE transect, 612 ft from edge of transgenic nursery. (Figure 4)

The higher pollen flow in 1998 was also seen in adjacent nurseries. Seed was sampled from a nursery 638 ft S of the transgenic nursery. Approximately two million seeds (160 g) were planted and three applications of Finale® were applied to the seedlings. Three hundred fifty-four seedlings were found to be resistant. Five plants were sent to a lab to confirm the presence of the bar gene. Seeds are also sampled from a Penn A-1 breeder seed field 1,417 ft (432 m) SW of the transgenic nursery and a Penn A-2 field just to the SE . Two million seeds were planted of each cultivar and two to three applications of Finale® were applied to the seedlings. After the second application of herbicide, no Penn A-2 seedlings survived; however Penn A-1 had survivors. Three plants survived and vegetative material was sent to a lab to confirm the presence of the bar gene with Southern Blot analysis. The lab confirm that the surviving plants from the two nurseries did contain the bar gene.

Fig 1: Overview of transects for pollen travel study

Fig 2: 1999 Overview at Transects for Pollen Travel Study

Fig 3: 1998 Transgenic Bentgrass Gene Flow

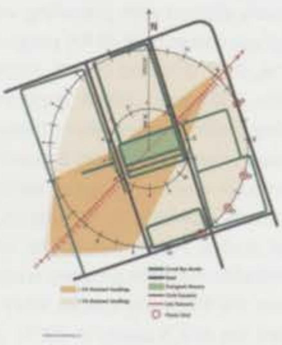


Fig 4: 1999 Transgenic Bentgrass Gene Flow

The same two nurseries (Penn A-1 and OVN) were retested in 1999. Penn A-2 was not tested, because the nursery was destroyed during the fall 1998. Again, 160 g of seed was planted from each nursery and sprayed with 2 to 3 applications of Finale®. No seedlings survived from the Penn A-1 nursery and 459 seedlings were recovered from the OVN nursery. A sample of these possible transformants is currently being tested for the bar gene.

This not only demonstrated that pollen was viable for at least 1,400 ft (426 m), but also established successful competition with non-transgenic pollen in a field situation. The Penn A-1 nursery was 0.1 ac (0.04 ha) in size, similar to that reported by Giddings (2000) with perennial ryegrass.

Inter-Specific Gene Flow

The crossing experiments resulted in the introgression of the bar gene from creeping bentgrass into *A. canina, A. capillaris, A. castellana, A. gigantea, A. pallens* and *A.* sp. (eastern Oregon). The following are the results from the different species of *Agrostis* that were planted within the transgenic nursery in 1998 and 1999.

Species	Origin or Code	N° of Survivors
A. canina	SR 7200	7
A. capillaris	9NC-20	13
A. capillaris	9NC-21	24
A. capillaris	9NC-78	0
A. castellana	New Jersey	51
A. castellana	Rhode Island	5
A. castellana	Oregon	32
A. curtissii	Portugal	0 (0 germination)
A. gigantea	Tennessee	1
A. gigantea	Tennessee	4
A. gigantea	Kentucky	5
A. gigantea	Kentucky	0
A. pallens	Oregon	4 (11.11 %)
A. pallens	Oregon	1 (4.76 %)

The results showed that the transgenic gene occurred not only between species known to cross with creeping bentgrass, but also with species native to Oregon. Future research will concentrate on the stability and fertility of the interspecific hybrids and include more native species in the study.

CONCLUSIONS

The results from the this study showed:
1) the transgenic bar gene can flow to other species of *Agrostis* (i.e. interspecific gene flow); 2) intraspecific gene flow in creeping bentgrass is possible for much longer distances than traditionally theorized; 3) the transgenic bentgrass plants were fertile and stable; and 4) the cereal rye was not an effective pollen barrier.

The distance that the creeping bentgrass pollen traveled was congruent with the documented gene flow from other wind pollinated and cross-pollinated species. Giddings (2000) determined that *Lolium perenne* pollen can easily travel a kilometer. Devlin and Ellstrand (1990), using a method of paternity analysis, reported a gene flow greater than 1 % at 8000 m distance in *Agrostis capillaris* (syn = A. tenuis). Gene flow from crop to weeds or feral populations via insect pollinators occurred up to one kilometer in: 1) radishes (*Raphanus sativus* L.) (Ellstrand et al. 1989; Klinger et al. 1991); sunflowers (*Helianthus annuus* (Arias and Rieseberg 1994; Whitton et al. 1997); and squash (*Cucurbita* spp.) (Kirkpatrick and Wilson 1988). Christoffer et al. (2002) studied transgene flow through the pollen of creeping bentgrass using transgenic glyphosate (Roundup®) resistant creeping bentgrass (RRCB) as a selectable marker. Experimental plots were created within a 110-acre production Kentucky bluegrass seed field irrigated by a 1275-ft center pivot in the Columbia Basin, WA.

Four hundred RRCB plants were planted into a 45-ft radius in the center of the study site. This nursery was surrounded by non-transgenic creeping bentgrass, plus 11 other species of *Agrostis* and three species of *Polypogon*. Pollen receptor plants of each species were planted as a five plant row within plots (80 x 45 ft) at 6, 165, 610, 900 and 1,200 ft from the edge of the RRCB donor plants along six axes radiating from the field center. Seed was harvested, cleaned and a 1.5 g sample was planted. Resistance to glyphosate was used as an indicator of successful hybridization between RRCB and receptor plants.

Transgenic creeping bentgrass pollen flow decreased as distance from the RRCB pollen donor increased. The transect line that was closely aligned with prevailing wind had the highest percentage of RR progeny with 49.8, 0.56, 0.38, 0.15 and 0.07 % recovery at 6-, 165-, 610-, 900-, and 1,200-ft, respectively. No interspecific or intergeneric herbicide resistant progeny were recovered beyond 165 ft; herbicide resistant progeny were recovered from *Agrostis capillaris, A. idahoensis, A. hyemalis var. scabra, Polypogon viridis,* and *P. fugax*. Herbicide resistant progeny were recovered from the following species when placed 2-9 ft from the RRCB plants in 2001: *Agrostis trinii, A. idahoensis, A. pallens, A. capillaris, A. gigantea, A. canina, A. vinealis, A. hyemalis* var. *scabra, Polypogon monspeliensis, P. fugax* and *P. viridis*. Given that the the pollen donor, RRCB, plants are hemizygous it can be assumed that RRCB hybridized with the receptor plants at approximately twice the frequency reported.

The data generated by Christoffer et al. (2002) is congruent with existing literature on gene flow from creeping bentgrass and other wind pollinated grasses.

Absolute containment of transgenes is undoubtedly often impossible. Genes can not only escape via the pollen, but also through seeds that are left in fields and lost during handling. Instead of asking whether absolute containment is possible, approaches that will maximize the level of containment should be the focus. The spread transgenes through the pollen to cross-compatible populations can be prevented by: 1) male sterility which will prevent development of pollen; 2) transformation of chloroplast, which will insure that the gene is only maternally inherited; 3) growing the crop in areas where no cross compatible populations exist; and 4) at the current pace of biotechnological discoveries and development, new technology, not even thought of today, will be developed in the future that could eliminate this problem altogether. The future of biotechnology is bright, unlimited and very exciting. This molecular revolution, like any other revolution that has occurred throughout human history, will go through growing pains. But through sound research to gather scientific data to make informed decisions and through public education of the perceived 'sci-fi' technology, the potential of this technology will be realized.

Please note that a complete list of references is available by contacting the Editor of ATM.

Joseph K. Wipff and Crystal Fricker are researchers with Pure Seed Testing, Inc. Hubbard, OR 97032. They are contactable at the following email address:

joseph@turf-seed.com crystal@turf-seed.com

Seed was sprayed with 2 to 3 applications of Finale®

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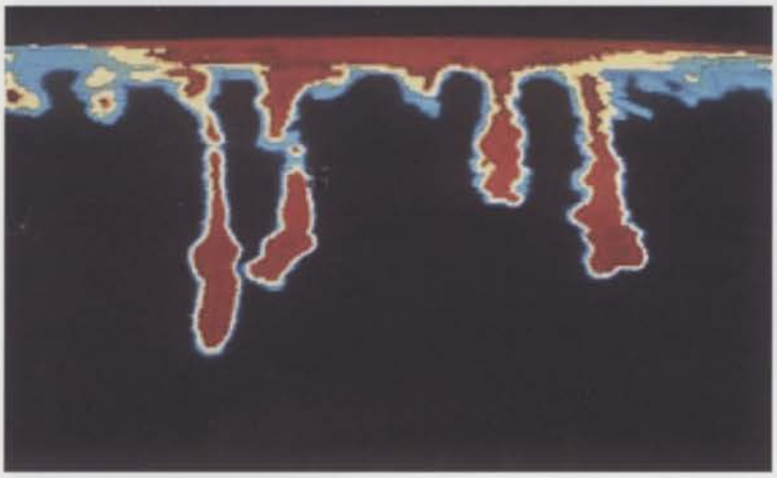

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By John Neylan

NEW ZEALAND VISIT

In July, I was fortunate enough to spend 8 days in the North Island of New Zealand as a guest of the Central North Island Turf Managers Association. Along with Stephen Marsden, Course Superintendent at Lakelands Golf Club, I attended the Associations seminar at Tauranga Golf Club.

It is always a challenging experience to share your knowledge from Australia and attempting to make it meaningful in another country, with at times very different environmental conditions. It is also of interest to realise that many of our own problems are also shared in New Zealand. The statement that best encapsulates the similarities between Australia and New Zealand is, "how to achieve higher standards of turf presentation without increasing the budget".

Waihi Golf Club

CENTRAL NORTH ISLAND TURF MANAGERS ASSOCIATION SEMINAR

Issues discussed (and argued) during the seminar including; *Poa annua* (principally its management as a surface), use of creeping bentgrass and its management, couchgrass as a fairway grass, and nutrition.

I found it interesting that many North Island golf clubs have decided to cultivate *Poa annua* as their grass of choice for putting greens. The kiwis have developed a very effective establishment technique using plant material taken as mini tyre cores from established greens and are getting a surface within 8-10 weeks.

While *Poa annua* was the predominant species on greens, I also saw some very high quality "Egmont" greens at Waihi golf club. The "Egmont" looked very much at home and the *Poa annua* had been kept at bay through the use of Paclobutrazol. The great challenge in keeping *Poa annua* at manageable levels is the relatively mild and often wet summers in the north island, conditions that suit the persistence of *Poa annua*.

The move of some golf courses to investigate the use of couchgrass for fairways reminded me of where Victorian golf clubs were 15 years ago. The clubs that are trialling couchgrass are having to deal with; establishment techniques, suitable cultivars, weed control, winter dormancy (loss of colour) and whether to keep it clean of *Poa annua*.

At the seminar we had a very intense debate on soil and plant nutrition, that included myself, Dave Ormsby (NZ Sports Turf Institute) and a representative from a soil testing laboratory. From my perspective there were four main points that came out of the discussion;

1. Do not use the results of soil analysis in isolation to the health of the grass and quality of the surface. Many high quality turf areas are maintained under acid pH, low soil available phosphorus and calcium/magnesium imbalances.
2. Use the results of soil analysis to determine the impact/result of your fertiliser program. They are not to be used as the 'be all and end all' in determining


Wairakei Golf Club

whether a particular element has to be applied.

3. Turf is a surface and not a crop. In producing golfing surfaces, we are not interested in biomass production but in what remains once the biomass is removed.
4. The importance of micronutrients, are somewhat overemphasised, when a single application of a trace element mix will often provide the necessary elements for years.

KAURI CLIFFS GOLF COURSE

In addition to the seminar, course superintendents Andrew Ellis and Steve Hackett took me on a trip to the far North to visit Kauri Cliffs Golf Course. This golf course is somewhat isolated and has been developed for the high income golfer. It is located on coastal cliffs where many holes play to the back drop of the ocean. The location and scenery is spectacular, and was only outdone by the wind on the day we visited. It is a very open, "links" style golf course except for 3-4 holes that meander through a beautiful wetland area. Having to play towards ocean back drops and across a deep gully, creates a strong illusion that distances are greater than what they really are.

The greens and tees are creeping bentgrass, the fairways are ryegrass and the roughs are fine fescues. The golf course is highly conditioned and presented to every paying customer in the best possible condition, whether there are one or 100 players.


Wairakei Golf Club

WAIRAKEI GOLF COURSE

I was also fortunate to visit Wairakei golf course where the course superintendent is Nigel Lloyd, a frequent visitor to our conferences. Wairakei is a very well presented golf course, in a "parkland" type setting, and is setting a high standard for New Zealand golf courses. What I found interesting is that while the Australian landscape often has a certain "harshness" and "ruggedness", the New Zealand landscape is somewhat "softer" and more European in appearance.

STAFF NUMBERS ON NEW ZEALAND GOLF COURES

One of the standouts when you visit New Zealand golf courses is the comparatively low staff numbers and the excellent results being achieved. A statistic quoted was that the average staff number was less than two. The comparatively mild summers would appear to be a bonus in achieving these results with a small staff.

I visited the course that my host Andrew Ellis runs with two plus himself. Waihi Golf Course is a well presented, parkland golf course with "Egmont" greens. It is built on volcanic ash, which is a peculiar material with the texture of talcum powder but has a very high drainage capacity. Waihi Golf Course had received 50 days of rain in the previous 60 days with an annual rainfall greater than 2 metres (2000 mm) and all turf surfaces were firm and dry. The golf courses on the volcanic ash are similar to the Australian "sand belt" type golf courses in that they are almost unaffected by rainfall. Even the greens are constructed and topdressed, with this "talcum powder" type ash and still exhibit excellent drainage.

New Zealand Sports Turf Institute (NZSTI)

During my New Zealand visit I spent a day at the New Zealand Sports Turf Institute (NZSTI) at Palmerston North. The NZSTI under the directorship of Keith McAulliffe, has established an enviable institution that serves all areas of the turf industry in New Zealand. The NZSTI has a very experienced group of agronomists, soil scientists and educators that provide a very solid base for consultancy, problem solving, project management and training. The NZSTI has a small area of trial plots and have been undertaking very interesting research into greens construction and management (this was presented at the Brisbane conference by Dr. Richard Gibbs).

Overall, it was a great trip and a pleasure to meet up with many familiar faces.

Water Budgeting: A Pratical Method

Part two: Rate of water loss by turf

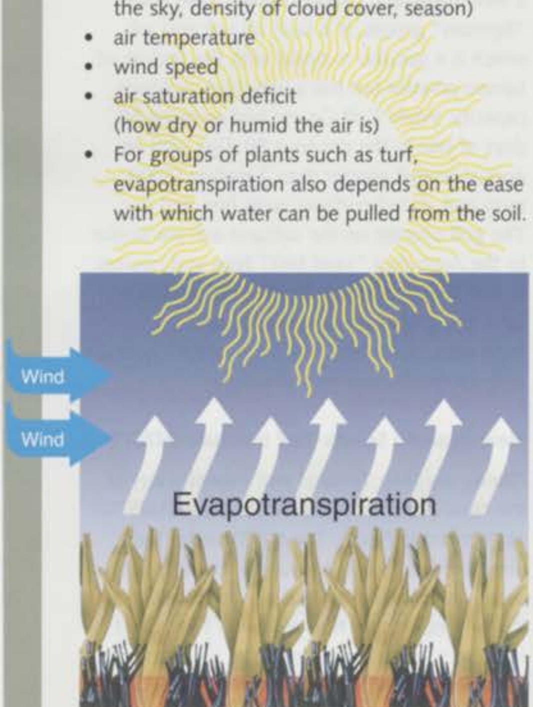
In Part 1 (ATM Volume 4.3), I showed how you can determine the size of the readily available water reservoir of a soil. This article is about the effect of climatic conditions on water loss by turf plants. The aim is to determine the time at which the soil reservoir needs to be replenished. Some notes on the efficiency of irrigation systems complete the picture.

EVAPOTRANSPIRATION

Just as water continually evaporates from any body of water such as a lake or swimming pool, so water continually evaporates from plants. Loss from plants is called transpiration. There will also be some evaporation of water from the soil beneath plants. The combined loss from soil and plants is called evapotranspiration.

The rate of evaporation from lakes and evapotranspiration from plants/soils depends on:

- radiation intensity (how high the sun is in the sky, density of cloud cover, season)
- air temperature
- wind speed
- air saturation deficit (how dry or humid the air is)
- For groups of plants such as turf, evapotranspiration also depends on the ease with which water can be pulled from the soil.



Evaporation rate is greatest during the early afternoon of a blisteringly hot summer's day when a fierce northerly wind is blowing and when air humidity might be only 5-10%. It is lowest on a freezing, calm, foggy winter's day.

The evapotranspiration rate for an area of constantly well-watered turf will be about the same as the evaporation rate from a nearby lake or swimming pool. It will be lower for turf whose growing medium has dried out somewhat.

DETERMINING EVAPOTRANSPIRATION RATES

There are several methods for determining the evapotranspiration rate for a particular area.

1. Calculation using a modified Penman equation

These equations use measurements of solar radiation, air temperature, wind speed and saturation deficit to calculate evapotranspiration rate. As no readers of this article, nor its author, will want to make these measurements, no more will be said.

2. Using Bureau of Meteorology data

The Australian Bureau of Meteorology (BOM) maintains a country-wide network of evaporimeters (see next point). The data from them has been compiled into a general data base that is available on CD Rom (for about $225). Information for specific areas can also be obtained, for a fee.

These data can be useful and should be used whenever better data are not available, but they can never be totally accurate for your course. This is because there can be considerable variation in evapotranspiration between different parts of an area, with the variation depending on such local influences as a body of water or a windbreak upwind, dry paddocks upwind, shading, aspect, local topography, etc. Even within one golf course there can be a 20% variation in evapo-transpiration at different greens. If you know that there is little variation across your course and those data from the nearest BOM weather station apply well to your area, you should use them. Otherwise you should measure evaporation on-site, as discussed next. This next section also gives details on how to use evaporimeter data.

3. Using an evaporimeter

An evaporimeter is really just a small lake in the form of a round, shallow tank of water. The standard evaporimeter used by the Bureau of Meteorology is called a Class A pan. It is 1.207 m internal diameter and 254 mm deep, made from 20 gauge galvanised steel.

It has been found that the rate of evaporation from an evaporimeter is about 1.25 times the rate of evaporation from a nearby lake or swimming pool. This is because the water in the evaporimeter is on average warmer than is the water in the lake. Put another way, a lake will lose water at about 0.8 of the rate of loss from an evaporimeter.

If you really want to get the most out of your irrigation water, you will install an

Evaporimeter

evaporimeter at a point on your course that is typical of most of the course. If water is frequently in short supply, or if you are using effluent water, I strongly recommend that you install an evaporimeter. By using it as I show below, you will be able to produce the best possible turf under what are probably difficult circumstances.

Full plans for the construction and use of a Class A pan are given in Agriculture Note AG0293 of the Victorian Department of Agriculture, which is available on the web.

Rather than buy or make a Class A pan, you can easily make your own evaporimeter from a steel drum of about 50 L capacity, or one of the blue or black plastic drums in which such foods as pickled gherkins and cherries are imported. A 300 mm length of one end is cut off for use. Steel will have to be painted inside and out with white or other light-coloured paint, to stop it rusting. Plastic drums should be painted with aluminium paint or have alfoil wrapped around their outsides.

Stick a plastic ruler to the inside wall, with its zero at about 50 mm below the rim. Place your evaporimeter in a non-shaded area that is typical of your course or of the main areas that you irrigate. Place it on a base constructed of one or two layers of bricks. Make a cover from wire netting so that birds and animals cannot drink from the evaporimeter.

These small evaporimenters give evaporation figures that are closely similar to those obtained with Class A pans. A full explanation of their use is given in Growing Media for Ornamental Plants and Turf (Handreck and Black), but briefly:

Fill the evaporimeter to about 50 mm below the zero line. Note the level in your record book. At the same time every day in summer or less frequently in other seasons, read and record the water level. Calculate a running total of evaporation. Rainfall that does not overflow the evaporimeter is automatically allowed for. Irrigate when the water level drops to the level that you have decided is the number of mm that can be lost before you irrigate. This number is calculated as follows.

Turf (crop) factors

Turf will lose water at the greatest rate if it is irrigated when only a small proportion of the soil's reservoir is used. The turf is never stressed, so it will have an evapotranspiration rate that is similar to that of a nearby lake. It will be losing water at about 0.8 times the rate of loss from that lake. This number is called the turf or crop factor.

If the turf is allowed to draw more water than this from the soil reservoir before the next irrigation, it will become slightly stressed. This stress reduces its growth rate, but it also decreases its transpiration rate, in part because stomates in its leaves partially shut and partly because it has to work harder to suck water from the soil. The amount of stress and growth reduction can be used as a means of minimising water use while still maintaining acceptable growth.

For good growth and acceptable appearance of warm-season grasses, a crop factor of about 0.6 can be used.

To continue our example, if a soil can lose 17.5 mm of water before irrigation is necessary, an evaporimeter can lose 17.5/0.6 = 29 mm before irrigation is necessary. When it has lost this amount, apply 17.5 mm of water to the turf, plus any extra needed to flush salts down the soil profile.

For a given level of turf quality, cool-season grasses are less tolerant of water stress than are warm-season grasses. A crop factor for acceptable quality for them should not be lower than about 0.7. Over summer, it will be closer to 0.8. The more erect their leaves, the higher the factor that must be used.

Irrigation systems

There is not space here to offer more than a quick comment on irrigation systems.

No turf irrigation system is 100% uniform. The further it departs from 100% uniformity, the greater will be the depth of water that must be applied to ensure that all parts of the area receive enough water.

Use a can test to determine the coefficient of uniformity of a sprinkler system. The coefficient of uniformity (CU) is calculated by the formula:

CU = (1 – (T/Axn))100, where

A = **mean depth of water in all the cans of a can test for 1 hour application**

n = **number of cans**

T = **sum of differences between each depth and the mean, regardless of whether it is positive or negative**

Any system with a CU of lower than 85% should be re-designed.

The can test can also be used to determine how long the sprinklers should be left on to allow every part of the area to receive the required amount of water. This is done via the scheduling coefficient (SC).

SC = A/lowest depth in the can test

Systems with an SC of up to 1.5 are considered acceptable

To continue our example: for a system with an SC of 1.3, the average amount of water to be applied is 29 x 1.3 = 38 mm.

If the system delivers on average 15 mm per hour (ie. A = 15), the 'on' time for the sprinklers will be 38 mm/15 mm/hr = 2.5 hours

A lake will lose water at about 0.8 of the rate of loss from an evaporimeter

A penultimate word

Don't totally trust the figures you get from an evaporimeter and calculate for the size of a soil reservoir. From time to time you should monitor the various areas of your course to see what is happening in the root zone. You might find that you need to increase or decrease the figure for the allowable reservoir size or the crop factor.

A final word

Sensor-based systems, such as Sentek's TurfScan, are now readily available for controlling irrigation of turf. Sensors buried in the root zone monitor soil water content. When the content reaches a pre-determined level the instrument switches on the irrigation system. It is switched off again when the sensor finds that the soil has reached field capacity. These systems are now widely used in production horticulture. They have an excellent track record where they have been used in turf. Their use will probably increase as water rationing becomes more common.

Kevin Handreck is the Managing Director of Netherwood Horticultural Consultants Pty Ltd, Adelaide. Evaporimeter photo courtesy of (BOM)

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Peter Frewin,
Golf Course Superintendent, Barwon Heads Golf Club.

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figure 1

(Energy saving up to 70% at partial load.)

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Delivering Pumping Solutions

Poa annua - if you can't beat em, join em!

Recently, Penn State's *Poa annua* breeding program and I under took a sabbatical in Melbourne, Victoria, the home of trendy restaurants, fine wines, and great people. It was heaps of fun and the entire experience was more rewarding, both personally and professionally, than I ever could have imagined.

David Huff (left) with David Aldous and John Neylan

One of my sabbatical projects was to collect strains of Poa growing on old golf course putting greens. I did this not to free greens of a pesky weed, but rather as Penn State's turfgrass breeder, one of my main projects is to breed and develop improved cultivars of annual bluegrass (*Poa annua*) possessing high turf quality for use on golf course greens. Now it is true that *Poa annua* is a major weed of golf course putting greens in Australia just as it is in many parts of the USA. But it is equally true that *Poa annua* is also a predominant component of some of the world's most elite golf course putting greens. In fact, most US Opens played in the past 15 to 20 years have been played on Poa greens rather than creeping bentgrass. Thus, *Poa annua*, despite its weedy image, is also capable of providing high quality putting surfaces. The reason why *Poa annua* can be both an ugly weed and a valuable putting surface is because not all Poas are the same.

There are basically three different types of *Poa annua*: 1) a wild, weedy annual type, 2) a short-lived, perennial type adapted to various turfs (lawns, fairways, tees, etc.) which I call "turf-type", and finally, 3) a long-lived, perennial type that thrives under the extremely close mowing heights of golf greens, which I call "greens-type". The greens-type *Poa annua* actually has many characteristics that enhance a putting surface. They typically have shoot densities that are 8 to 20 times higher than bentgrass, an upright growth habit that reduces (or eliminates) grain, and are highly adapted to and aggressively inhabit golf greens maintained at close (< 2mm) mowing heights. Thus, it may be no real surprise that many Australia superintendents, like so many of their American counterparts, have come to accept and even encourage Poa as a putting surface.

From Sydney to Melbourne to Adelaide, I met superintendents who had nearly pure Poa greens who have no intentions of converting to bentgrass. The acceptance of *Poa annua* as a putting surface seems to be reaching a pinnacle in Auckland, New Zealand. At Patanuga Golf Course, where I gave a Poa workshop, I witnessed bentgrass greens being lifted as sod and thrown into the compost pile. These greens were predominantly creeping bentgrass (Agrostis stolonifera Sibth.) not the Colonial or Highland types of bentgrasss that can be found on minimal maintenance golf courses in that region. In its place, superintendent Mr. Mike Davies was vegetatively planting mini-tine cores of *Poa annua* collected from his old greens. Dave is able to establish puttable playing surfaces after only 6 to 8 weeks grow-in and he is on a program to re-surface his remaining bent greens (Fig. 1). It was at another one of New Zealand's top golf clubs, where superintendent Mr. Steve Hookway, Titirangi Golf Club, developed and perfected this technique of Poa establishment and is similarly re-surfacing his greens when the opportunity arises (Fig. 2).

I felt like I was preaching to the choir at my *Poa annua* workshop. These guys were doing things with Poa that I had only thought about! It seems Dr. Joe Vargas, Michigan State Uni, had visited here about 10 years earlier and had planted a seed of an idea that Poa was the way to go for these Auckland supers. Three years after that, a visit from Instructor Tom Cook, Oregon State Uni, reinforced Vargas' ideas. Shortly after Cook's visit, management techniques began to change to distinctly favour the Poa and several years ago Steve Hookway at Titirangi began re-surfacing his bentgrass greens with Poa. Rick has also tried something that I and another Penn State faculty are only now beginning to play with – that is, growing Poa greens in less than the standard 11 to 12 inch depth of a medium-sized, uniform sand profile. Four years ago, Rick built a practice green using only 8 inches of his standard root zone sand mix. For Rick, this green has performed no differently than his other sand-based greens built to 11 inch depths. While I couldn't recommend this practice right now (it's a dangerous under-taking), Dr. Andy McNitt at Penn State and I are currently investigating the potential of shortening up the depths of sand-based root zones by measuring water use rates at various depths using different sands.

In every region I have visited in Australia, with the exception of Brisbane, I met superintendents who were managing pure Poa greens who had no intentions of converting to bentgrass. Annual bluegrass (*Poa annua* L.) is also known as "wintergrass" because it normally behaves as a winter annual in Australia just as it does in our southern states. However, unlike our southern states where it's common practice to overseed dormant warm-season grasses in the fall with a cool-season grass like perennial ryegrass or rough bluegrass, I also found some Australian golf course superintendents who use *Poa annua* as their naturally re-seeded, winter playing surface for their couchgrass (bermudagrass) fairways. From the famed Dr. Alister MacKenzie designed Royal Melbourne to some local backwater clubs, I learned that *Poa annua* is actually a desired fairway playing surface from May through November. The amount of Poa that naturally occurs on a fairway is regulated during spring transition by timing an application of non-selective herbicide. If the Poa is a little thin in one year, then fairways will be sprayed after Poa seed-head formation to ensure plenty of seed for next year. If the Poa was "Chokka block" (too thick) then the fairways are sprayed prior to flowering to reduce it's abundance next year. A very natural system.

Stephen Newell from Kooyonga GC with David Huff

After screening thousands of Poas collected from around the world, my breeding program has recently come up with our top 12 selections. These top 12 have been established from seed on golf courses in the states of Pennsylvania, New York, Washington, and California to evaluate their performance. While I was in Australia, we also established a similar evaluation trial at a links course near Melbourne (Barwon Heads Golf Club). Many of the problems associated with Poa greens in the States are also problems experienced here in Australia: things like susceptibility to anthracnose, lack of heat tolerance, and seed head production under greens-height of cut. And just like the USA, the quality of *Poa annua* existing on greens is highly variable, both within and among Australiasian golf courses (Fig. 3). Thus, while my breeding program is focused on improving many of the deficiencies of Poa, it's the unavailability of a uniform seed supply of sufficiently high quality for putting greens that seems to be the most serious problem requiring an immediate solution. Thus, the ultimate goal of the breeding program is to provide seeded commercial cultivars of high quality *Poa annua* for use on golf course putting greens (Fig. 4). As the breeder at Penn State, I also like to add that my goal is not to replace bentgrass as a putting surface, but rather, to offer an alternative to those golf courses where *Poa annua* is simply a better choice.

Author's acknowledgement: *Thanks to all the down-under supers who showed me around their courses and special thanks to Mr. Brian Way and Mr. Peter Munro, New Zealand Sports Turf Institute; Mr. John Neylan, Australian Golf Course Superintendents Association; Dr. David Aldous, Melbourne Uni; and, Jyri Kaapro, Bayer Environmental Science for their persistence, patience and good friendship.*

Dr. David R. Huff is an Associate Professor within the Department of Crop and Soil Sciences, Pennsylvania State University, University Park, Pennsylvania, USA

Fig: 1

Fig: 2

Fig: 3

Fig: 4

Fig. 1. Superintendents attending the *Poa annua* workshop held at Patanuga Golf Course, Auckland, NZ inspect Mr. Mike Davies' green converted from creeping bentgrass to Poa.

Fig. 2. A 6 week old *Poa annua* green vegetatively established by superintendent Mr. Steve Hookway, Titirangi Golf Club, Auckland, NZ.

Fig. 3. *Poa annua* collected from two different Australian golf clubs (Club A on the left and Club B on the right) shows lots of variability just as it does in the USA.

Fig. 4. One of Penn State's greens-type *Poa annua* surrounded by creeping bentgrass.

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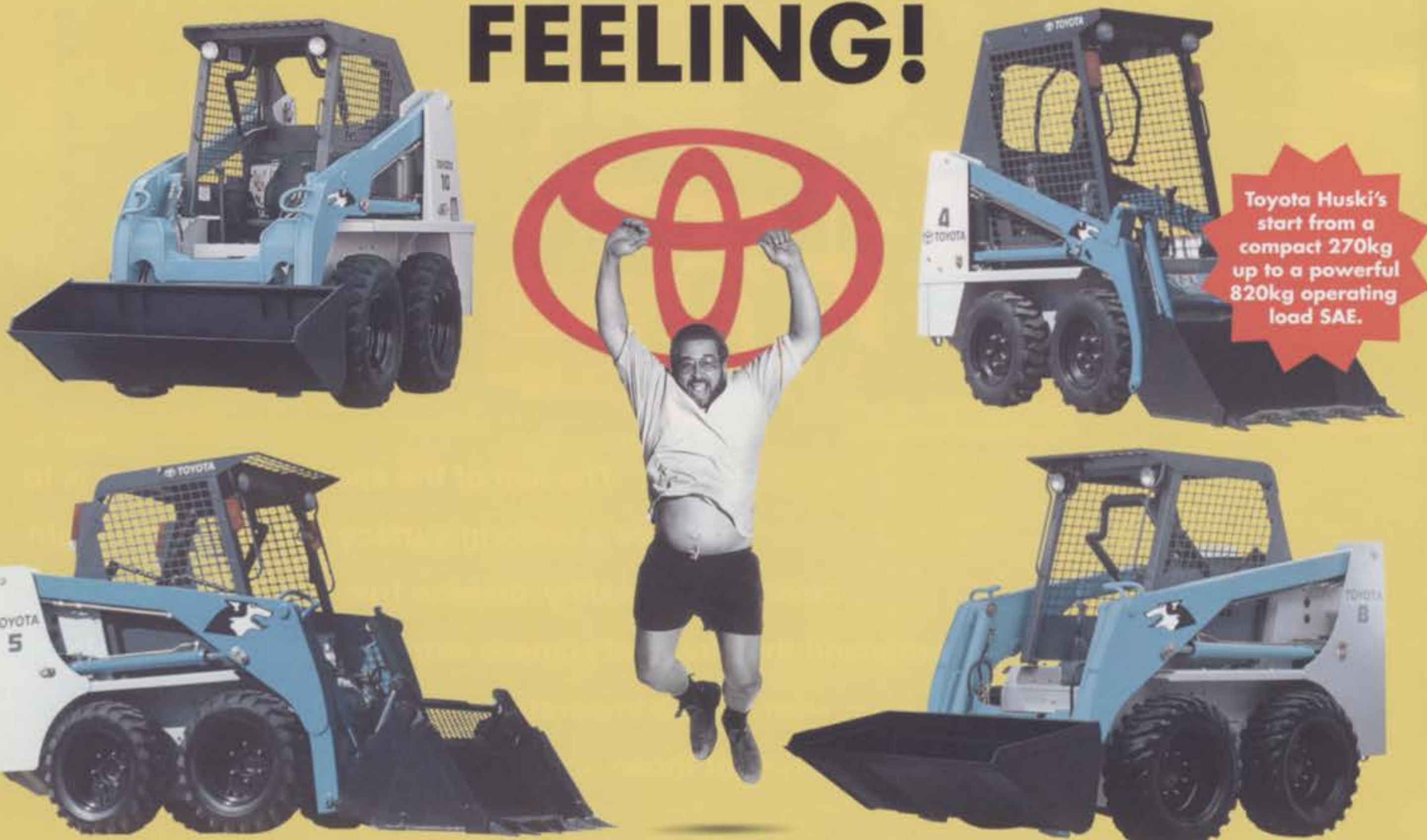

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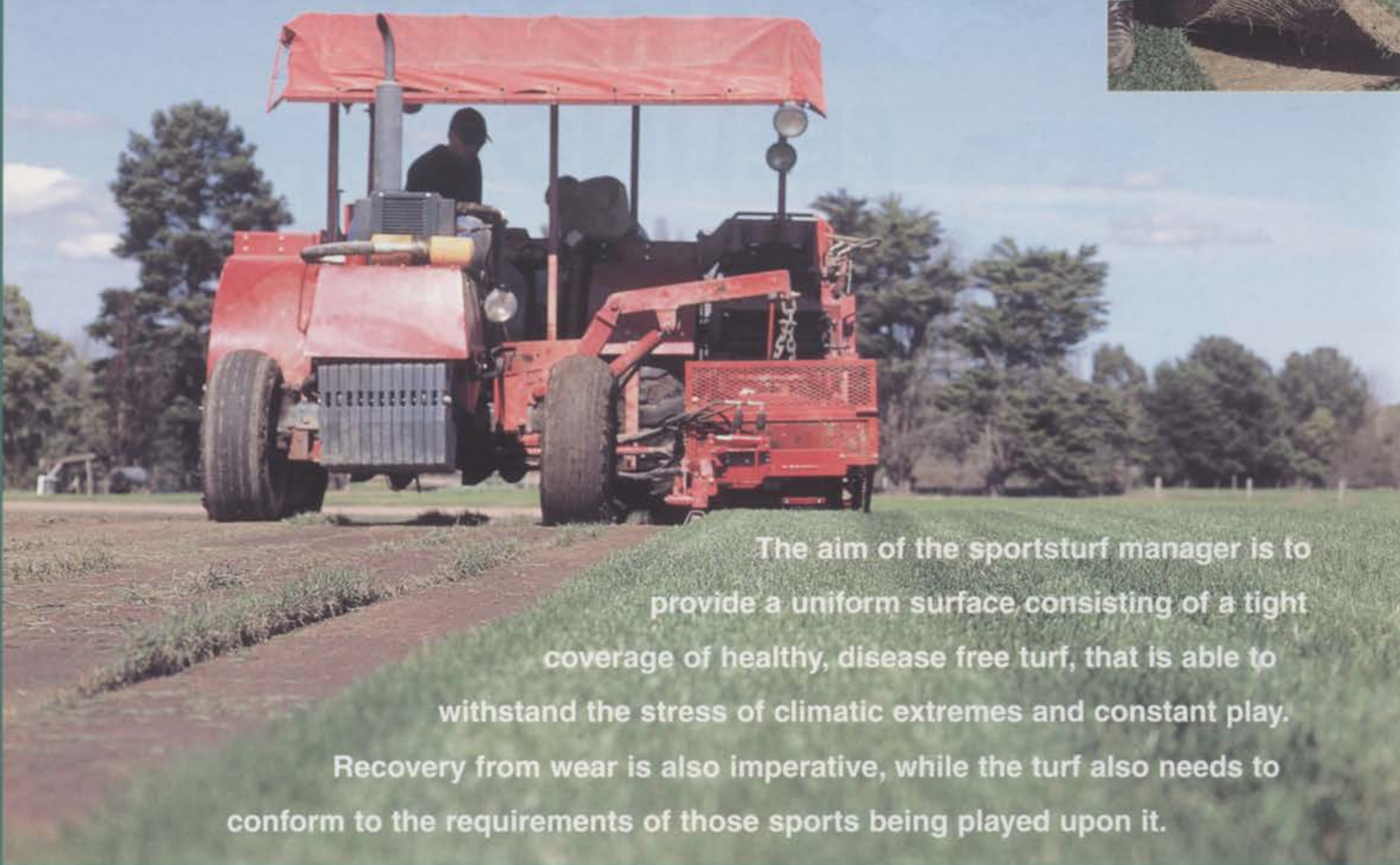
Nutritional Requirements of Sportsturf



The aim of the sportsturf manager is to provide a uniform surface consisting of a tight coverage of healthy, disease free turf, that is able to withstand the stress of climatic extremes and constant play. Recovery from wear is also imperative, while the turf also needs to conform to the requirements of those sports being played upon it.

Nutrition plays an important role in carrying out the above objectives. The aim of this article is to examine the nutritional requirements of turf.

There are sixteen elements directly involved in plant nutrition, which are necessary for the turfgrass plant to complete its lifecycle. See table below

Each essential nutrient is equally important in that a deficiency of any one can seriously impair the overall plant growth and development process.

Table 1

MACRONUTRIENTS		MICRONUTRIENTS
Obtained from carbon dioxide and water	*Obtained primarily from the soil*	
Carbon (C) Hydrogen (H) Oxygen (O)	Nitrogen (N) Phosphorus (P) Potassium (K) SECONDARY NUTRIENTS Calcium (Ca) Magnesium (Mg) Sulfur (S)	Iron (Fe) Manganese (Mn) Zinc (Zn) Copper (Cu) Molybdenum (Mo) Boron (B) Chlorine (Cl)
(Beard, 1973)		

More emphasis is usually placed on the macronutrients as these nutrients are generally needed in greater quantities by the plant when compared to micronutrients.

Carbon, hydrogen and oxygen are required for production of carbohydrates, proteins and lipids. Since these three essential elements are contained in most organic compounds found in plants they have a major function in plant growth. However, they are supplied continuously by air and water , and therefore they are not focused on in discussions on nutrition.

Nitrogen (N)

Nitrogen is the element used in the greatest quantity by turfgrass. Nitrogen is a component of many important constituents within the turfgrass plant including chlorophyll which is involved in photosynthesis, amino acids and proteins which make up a large proportion of the plants cell and enzymes and vitamins which speed up metabolic reactions in the plant.

A healthy turfgrass plant usually contains 2-6% nitrogen. Nitrogen is the 'growth control element' as the amount of leaf growth is directly related to the nitrogen output. The quantity and timing of nitrogen applications have a wide range of effects on turf quality including shoot growth and density, root growth, colour, hardiness, stress tolerance and recuperative potential (Beard, 1973).

The most common problem in applying nitrogen occurs when application of readily available N is too high. This encourages a flush of succulent leaf growth. This type of growth effectively weakens the plant, as a large amount of leaf growth requires more carbohydrates. When over application of nitrogen occurs the shoots have priority over roots in the utilisation of carbohydrates, which results in decreased root development and subsequently, this has a negative effect on turfgrass sustainability. Excessive leaf growth also produces a decrease in cell wall thickness and actually increases cell size, providing a more favourable environment for disease and insect penetration. Furthermore, stress tolerance tends to decrease due to the 'weak' nature of the turfgrass cells.

Ideally, nitrogen should be used with moderate levels being administered on a more regular basis. This will provide constant growth, while beneficially minimising clipping removal, maintaining colour and allowing adequate growth to recover from wear.

At the other end of the scale, by not applying enough nitrogen, turfgrass lacking in growth and density will result. Nitrogen deficiency is also characterised by a loss of colour in the older leaves.

Phosphorus (P)

Phosphorus is an important element for turfgrass sustainability. Its primary role is in the storage and transfer of energy within the plant. It is also essential for the formation of DNA in new cells and for root growth and development. Because phosphorus increases root development, this element is used in large quantities by the plant at the seedling/stolon stage. Phosphorus is usually found in higher concentrations in young plant tissues where cell division is taking place. (Anon. 1987)

Phosphorus does not move or leach readily due to its low solubility in the soil solution, and tends to accumulate to very high levels in most soil types. The exception to this being very sandy soils where leaching of phosphorus has been experienced.

Due to the low solubility of the phosphorous compound accumulated phosphorous is largely unavailable for turf uptake. As a result, levels continue to rise. An inorganic fraction of phosphorus does release small quantities over a period of time that is available for plant uptake. However, it takes many years for this element to be reduced to normal soil levels given that the rate of release is extremely slow and that established turfgrasses only use relatively small amounts of phosphorus.

To put the quantity of phosphorus needed by the plant into perspective many publications suggest that turf needs as much sulfur, calcium and magnesium as it does phosphorus (McCarty 1999).

Due to past fertility programs, whereby high phosphorus fertilisers were recommended a large proportion of Australia's sportfield's suffer from high phosphorous levels in the soil profile. High levels of phosphorus characteristically cause problems to turf managers in that they often tie up trace elements in the soil, preventing turfgrass uptake. Furthermore, *Poa annua* (wintergrass) infestations usually increase in soils containing high P as these soils favour *Poa annua's* prolific seed germination. (Christains, 1998)

Phosphorous deficiency typically conveys a purpling on the leaves and stolons. This usually occurs in winter as the plant at this time of the year has little metabolic energy to expend on the uptake of phosphorus, hence deficiency appears.

Potassium (K)

Turfgrasses require potassium in relatively large amounts, second only to nitrogen. Potassium is referred to as the turf 'toughener' and its main purpose is to improve stress tolerance. It is an ideal element to be used in conjunction with nitrogen, as while N produces cell growth, potassium strengthens the walls of the cell, hardening it to aid resistance to disease and pest infestation. Potassium is also important for many plant processes and it performs the following functions:

1. Regulation of the opening and closing of the stomata, which effectively improves heat and drought tolerance.
2. Production of proteins and carbohydrates. Potassium also assists in moving these compounds throughout the plant. This becomes very important for winter survival and recovery.
3. Controls uptake of certain nutrients.
4. Increases root development, enhancing greater branching of the root system. This contributes to improved drought and wear tolerance.

Turfgrasses have the ability to take up far greater quantities of potassium than that required for plant growth, without showing any beneficial effects. This is referred to as luxury consumption. While this is not harmful to the plant, large quantities of potassium can restrict the uptake of magnesium. In addition, potassium is readily leached through the soil profile, therefore very large single applications are best avoided.

Potassium deficiency symptoms include interveinal yellowing of older leaves, and the rolling and burning of the leaf tip. The leaf veins eventually appear yellow and the margins appear scorched. Furthermore, the turfgrass plant will also rapidly deteriorate when subjected to stressful conditions.

Calcium (Ca)

Calcium is an important secondary nutrient required by the plant to strengthen cell walls and prevent their collapse. Calcium also plays an important role in cell division (plant growth) and the production of carbohydrates and proteins. Furthermore, calcium performs other important functions, such as its effect on soil acidity, soil structure and cation exchange capacity.

Calcium is an immobile nutrient within plants. Therefore it does not move from older leaves to new ones and must be supplied continuously or young leaves will show deficiency symptoms. However, deficiencies are rare in turf as calcium is supplied frequently to soils through lime, dolomite and gypsum. When a calcium deficiency does develop, it usually occurs in alkaline soils with a low cation exchange capacity.

Symptoms of deficiency include young leaves that are distorted in appearance and turn reddish brown along their margins. Eventually the tips and margins wither and die.

Magnesium (Mg)

Magnesium is essential for chlorophyll production in plants. Chlorophyll molecules contain approximately 7% magnesium. Magnesium also plays an essential role in energy transformations such as the conversion of carbohydrates to sugars. It acts as a carrier of phosphorus in the plant and regulates the uptake of other nutrients. Magnesium is a mobile element in the plant and is easily translocated from older to younger plant parts as required. Symptoms of deficiency include a general loss of colour, particularly the older leaves. Interveinal chlorosis then occurs.

Sulphur (S)

Sulphur is a building block for amino acid, protein and chlorophyll formation. The acidifying effect of sulfur may increase the availability of essential elements such as iron, manganese and phosphorus and help reclaim sodic soil. Sulfur content in tissues ranges from 0.15 - 0.5%. Sulphur is generally not applied as a separate application, as it is regularly used in NPK fertilisers as ammonium sulphate or potassium sulphate. Sulfur is produced from the decomposition of organic matter in the soil. Therefore deficiencies may occur when soil organic matter is low, grass clippings are removed, excessive watering occurs and the soil type is predominantly low in cation exchange capacity. Deficiency symptoms resemble N deficiency and include an initial light yellow-green colour, with yellowing being most prominent on younger leaves as sulfur is mobile throughout the plant.

Micronutrients

Iron (Fe) is the micronutrient most commonly deficient in turf. It is often present in the soil in large quantities, but uptake is restricted by high phosphorus levels, very alkaline or water-logged soil condition. The main function of iron is the production of chlorophyll. This produces a rapid greening of the turfgrass and is often used where aesthetics are important. Iron also increases root growth during the growing season.

The quantity of iron found in plant tissues is relatively small and it is quite immobile in the plant. Iron deficiency is therefore displayed in new growth, as the small amount of iron that is in an iron deficient plant cannot be distributed to these new areas of growth. Iron deficiency in the early stages is characterised by interveinal chlorosis on the turfgrass leaf which tends to have a light green to yellow appearance. In severe cases leaves turn white and eventually die.

Other micronutrients are rarely individually included in turfgrass fertility programs. Manganese is closely associated with iron in that it is required for chlorophyll synthesis. Thus a manganese deficiency results in discolouration to the turf. It is usually most abundant in actively growing tissues such as the leaves. An excessively high concentration of iron in turfgrass tissues can induce manganese deficiency.

Zinc is essential to turfgrass but only in minute quantities. Excess zinc can cause turfgrass damage. Zinc is associated with plant hormone and auxin development. Zinc availability is often restricted under alkaline conditions.

Similarly to zinc, copper is needed by the turf plant in very small amounts. It is also associated with plant hormones and enzyme systems. The copper content is usually highest in actively growing tissues. Deficiency can cause death of emerging buds.

Molybdenum is only needed in small quantities and is primarily associated with enzyme systems. Plant tissues tend to accumulate molybdenum as they mature. Deficiency results in reduced protein production.

Boron is thought to influence metabolism of carbohydrates and the uptake of certain nutrients into the plant.

Nutrient Application Timing

When planning a fertility program, the role of each nutrient needs to be examined along with the times of greatest demand within the plant. The program below could be used as a guideline for a warm season grass nutrient program: *(See table 2 below)*

It is important that any nutritional program is based on a soil test. This provides an accurate account of both the nutrient levels and imbalances in the soil, and the factors which affect nutrient uptake (pH, CEC). Soil testing is best carried out in late winter before renovation, as amendments (calcium, magnesium and trace elements) can be incorporated into the soil as the renovation is carried out, limiting unnecessary disruption to the playing surface at other times of the year.

Table 2

SEASON	SUGGESTED PROGRAM
Winter	Carry out soil analysis
Spring (renovation)	Calcium + magnesium Trace elements if soil analysis indicates. Phosphorus Nitrogen Organics
Summer	High nitrogen, lower potassium applications
Autumn	Lower nitrogen, high potassium, iron application

Phosphorus can also be applied at renovation if a deficiency exists or if a heavy renovation is carried out where leaf is removed and regrowth and root development are necessary. Nitrogen must also be supplied for rapid regrowth while some potassium is helpful.

During the summer growth season nitrogen is important to initialise growth. Potassium is also important in order to balance growth and provide a strong cellular structure for the plant minimising disease and insect outbreaks. A ratio of 4 parts nitrogen to 1 part potassium is usually what is applied during this period. In golf greens and cricket wicket areas under excessive traffic the ratio would be closer to 1 part N to 1 part K.

In autumn, the aim is to reduce leaf growth and encourage root growth. It is also important to strengthen the existing sward to help it cope with the stress of winter conditions. This is undertaken by reducing nitrogen levels and increasing potassium to a ratio of 1 part nitrogen to 2 parts potassium. These higher levels of potassium will toughen the plant while also encouraging carbohydrate storage and root growth. Also, iron supplements are most effective at this time of year.

Quantity of Nutrient Application

The ratio of nutrients removed by the plant and found in leaf tissues is an NPK of 8:1:5 (Street, 1998). Therefore a logical method would be to base an annual fertility program around a ratio similar to this.

Handreck and Black (1994) suggest that NPK applications be confined to the following quantities on an annual basis in order to maintain adequate growth and turfgrass health:

NUTRIENT	MINIMUM ANNUAL NUTRIENT APPLICATION LEVELS THAT SUSTAIN TURF GROWTH	MAXIMUM ANNUAL NUTRIENT APPLICATION LEVELS THAT SUSTAIN TURF GROWTH
Nitrogen	160kg/ha	400kg/ha
Phosphorus	30kg/ha	50kg/ha
Potassium	80kg/ha	240kg/ha

(Handreck and Black, 1994)

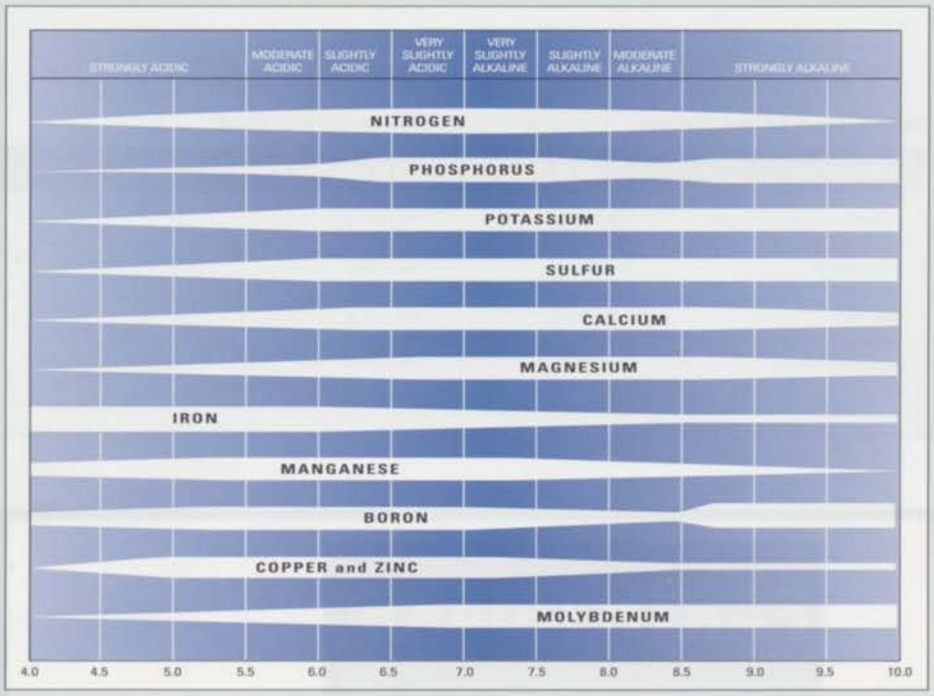
Table 3. Warm Season Grasses – N requirements per 100 sqm/growing month

GRASS	GENERAL TURF	RECREATIONAL TURF
Couch (common types)	98-195g	195-342g
Couch (hybrid)	195-293g	293-732g
Centipede	0-146g	146-195g
Kikuyu	98-146g	146-293g
Buffalo	146-244g	195-293g
Zoysia (common)	49-146g	146-244g
Zoysia (hybrid)	98-146g	146-293g

Table 4. Cool Season Grasses - N requirements per 100 sqm/growing month

GRASS	GENERAL TURF	RECREATIONAL TURF
Colonial Bentgrass	146-244g	195-390g
Creeping Bentgrass	146-293g	146-488g
Fine Fescues	98-195g	146-244g
Kentucky Bluegrass (common)	49-146g	98-293g
Kentucky Bluegrass (improved)	146-195g	195-390g
Perennial Ryegrass	98-195g	195-342g
Rough Bluegrass	98-195g	195-342g
Tall Fescue	98-195g	146-342g
Wintergrass	146-244g	195-390g

(Carrow et al 2001)



As already stated, with nitrogen being used in the greatest quantities by turfgrass, most attention is usually paid to N input by the turfgrass manager. Carrow et al (2001) left, provides the N requirement for the majority of turfgrasses grown in Australia on a per growing month basis.

Soil pH and its effect on nutrient uptake

Nutrient deficiencies can be induced in both acid and alkaline conditions. pH is the measure of the number of the hydrogen ions available in the soil. An, acidic soil results when the number of hydrogen ions (H^+) outnumber hydroxyl ions (OH^-). In acid soils common nutrient deficiencies occur with molybdenum, phosphorus, nitrogen, calcium, potassium and magnesium. Neutrality occurs when the hydrogen and hydroxyl ion concentrations are equal. Soil alkalinity occurs when the number of calcium, magnesium or sodium ions outnumber hydrogen ions reducing exchange sites on the soil particle for which hydrogen can bond. Nutrient deficiencies resulting from alkalinity are common with boron, copper, zinc, iron and manganese. Left, is a diagram outlining nutrient availability as influenced by soil pH.

In conclusion, turfgrass nutrition is a complex subject that the turfgrass manager must understand in order for a high quality playing surface to be produced. Hopefully this article has helped explain some of the major issues in turfgrass nutrition and a better understanding has been gained.

Peter Kirby is Technical Assistant with Nuturf P/L
**Lead picture courtesy of Lillydale Turf Farm.*
**A reference list is available by contacting the Editor*

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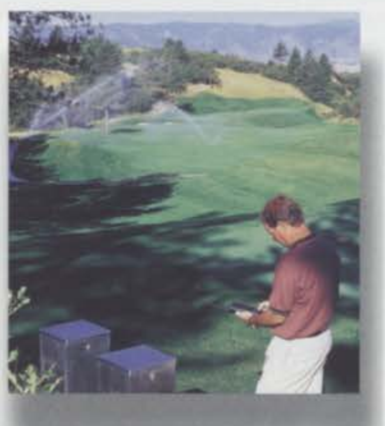

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2002 JOHN DEERE WORLD TEAM CHAMPIONSHIP

John Deere World Team Championship has been operating in the USA for the past 14 years and is now in its second year in Australia.

The team make up for the event consists of four players from one golf club, these being the Manager, President, Superintendent and club Professional competing in a modified scramble event. With state championships being held in Perth, Adelaide, New South Wales, Queensland and Victoria. The first and second placegetters going to Queensland to play in the Australian Team Championship held at The Glades Golf Course on the 2nd and 3rd October 2002. The winner of the Australian event will then be invited to play in the World event to be played at Greyhawk Golf Club, Scottsdale Arizona, USA, from the 21st to 24th November 2001.

The Victorian event was proudly organised and sponsored by Glenmac Sales & Service on the 23 July 2002 at the Moonah Links Golf Course, which was beautifully, prepared by Superintendent Leigh Yanner and his staff.

The players had to contend with a true test of golf under sunny skies and a cold lazy wind (goes through you not around), which luckily abated as the players got into their rounds and many teams registered excellent scores.

Winning teams were Gisborne Golf Club represented by Roy Hodges, Bill Willis, Ray Keane and James Wright with a team score of 61, who won on a count back from The Metropolitan Golf Club represented by Ian Sinclair, Allan Shoreland, Richard Forsyth and Craig Funch.

All those who participated had a most enjoyable and fun day and we look forward to an even bigger event next year.

Further details on the John Deere Team Championships call: John Deere - 1800 800 981

Metropolitan Team

The winning team from Gisborne Golf Club

REACHING OUT

Turf Careers day at Riversdale Golf

Recognising a need to do more in servicing Turf Apprentices and Groundstaffs, the AGCSA in conjunction with the VGCSA hosted a 'Turf Careers' day at the Riversdale Golf at the end of July.

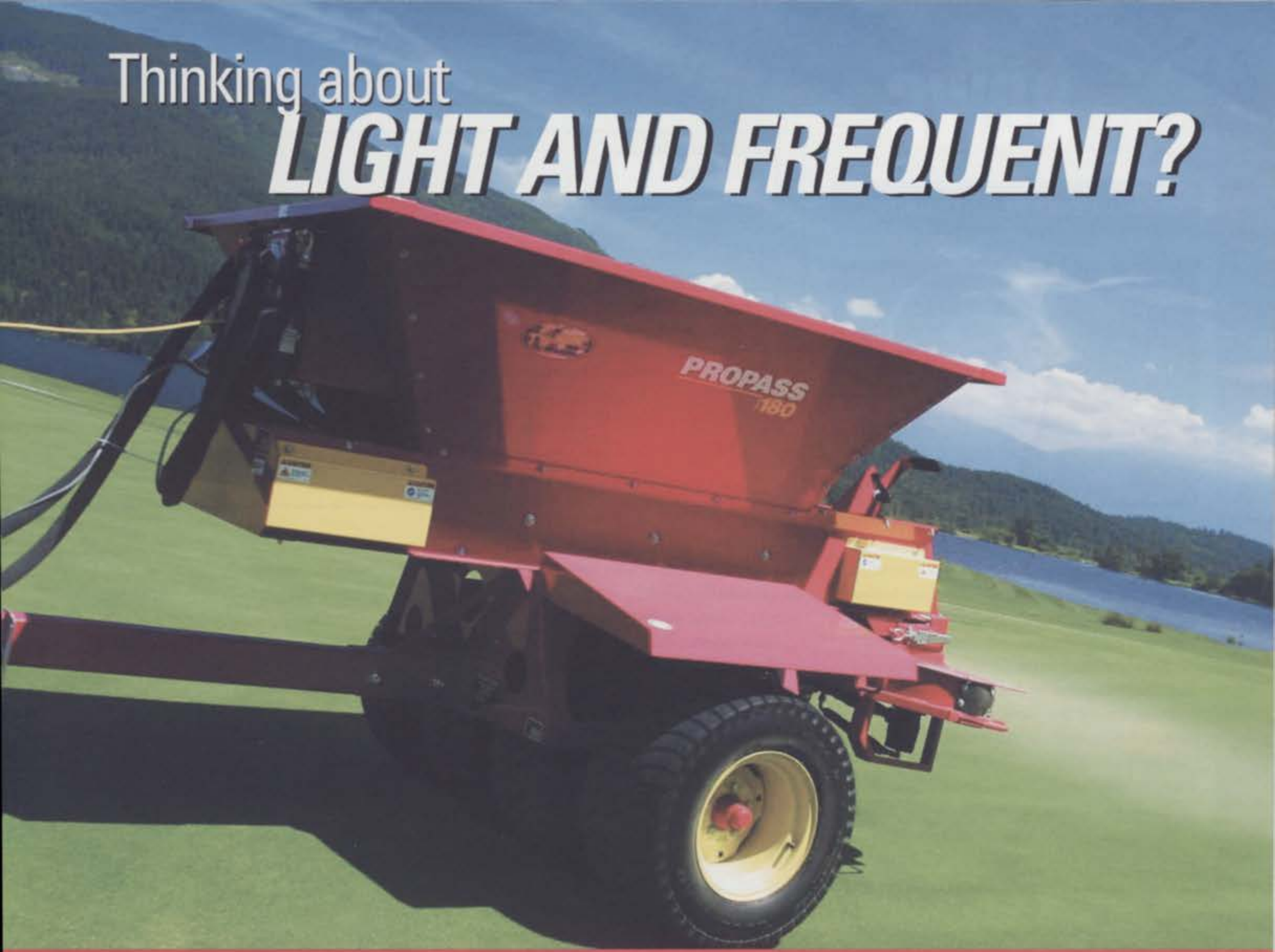
Just on 90 2IC's, apprentices and groundstaff crew were in attendance to listen to respected turf managers Peter Frewin (Barwon Heads GC), Richard Forsyth (Metropolitan GC), Martin Greenwood (Kingston Heath GC), Michael Picken (Riversdale GC) and Robert Savedra (Wesley College) talk about how they made it to the top of their profession and what they believed would help those following them enjoy similar success.

Key points emerging from the passionate discussions included the following:

- The successful modern turf manager needs to know much more than just how to grow grass. Equip yourself with management skills and seek some basic financial management training.
- Actually sit sown and PLAN your career.
- Be prepared to travel and/or take a step backwards/sideways in order to achieve your long-term career goals.
- Put in the extra yards to make sure you stand out from the pack – it's a tough game!

Also presenting on the day were representatives from Burnley College, Northern Metropolitan Institute of TAFE and Primary Skills Victoria.

Feedback from the day was extremely positive and as a result, there are plans to take the 'Careers Day' to other states.



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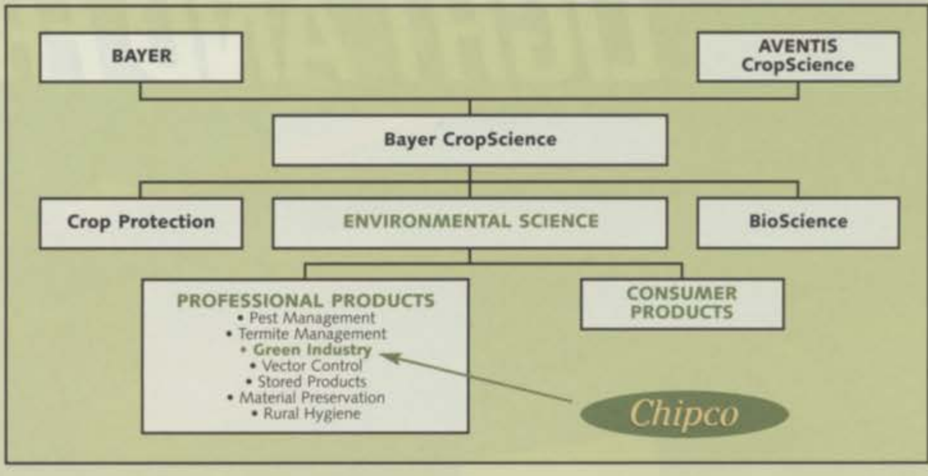
David Jerram, Bayer Environmental Science



As of the 1st August, Aventis CropScience and Bayer AG have united to form Bayer CropScience.

Bayer CropScience consists of three business groups, Crop Protection, BioScience and Bayer Environmental Science.

Bayer Environmental Science is a specialty business group that is dedicated to non-crop markets around the world. These markets include key business areas such as:
Turf products (Chipco), Pest Management Professional, Termite Management, Stored Products and Consumer Brands.

It is hard to keep track of all the mergers these days but the chart above may help?

In Australia, Bayer CropScience will be based in Melbourne, with a large network of regional development specialists, area managers and crop specialists located around the country.

David Jerram has been appointed as General Manager of the Environmental Science division and when interviewed by ATM at the media launch of the new company David said:

"formation of the new company has provided us with the opportunity to produce an 'A' team, bringing the best from both companies to allow us to deliver a better standard of service and technical expertise"

"We are committed to partnering industry for growth and will make a significant commitment to R&D into turf products in Australia."

For further information, please call Bayer CropScience on (03) 9248 6888.

'ROYCE ROLLS EM'

Royce Bannon, John Haines and Steven Lelli (Silvan)

In August the Victorian Turf Equipment Technicians Association (VTETA) had their AGM at their Head Office of Silvan Australia. It was our fourth meeting of the year and also our final one.

Silvan Pumps & Sprayers (Aust.) also came up with the concept of the Technician of the Year Award. This year the award was won by Royce Bannon from The Dunes Golf Club. In recognition of the award he received a trophy and a 'Jump Start Pack'. Our congratulations go to Royce on a well deserved award.

Other companies that showed interest in the day were Mick Licht Glenmac (John Deere) who brought along their new model rough cutter 1445. Also in attendance was Ted Boltong from Active Safety who had a range of safety equipment on display. The day was a great success and was well attended.

Our thanks go to Steve Lelli and Amanda Perez and all the staff at Silvan.

The newly elected committee for 2002-03

President: John Haines, *Kew Golf Club*
Vice President: Mark Browne, *Eastern Golf Club*
Secretary: Greg Stringer, *Green Acres Golf Club*
Treasurer: Gary Lay, *Sorrento Golf Club*

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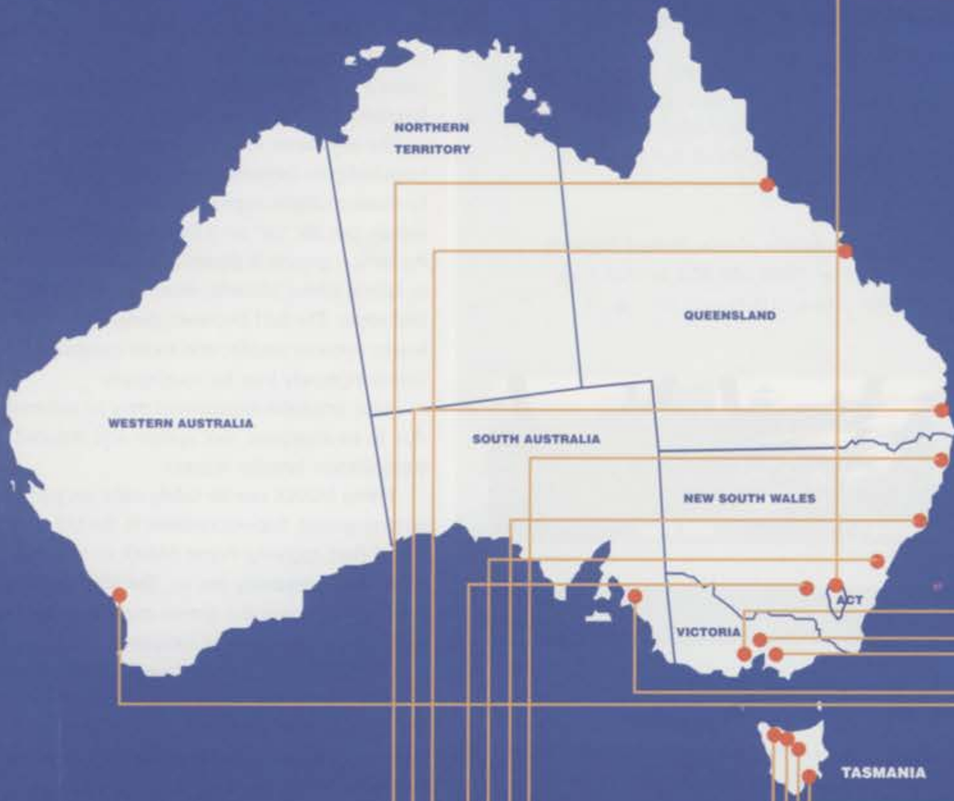

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CROWN III RECYCLED RUBBER TOP DRESSING

A revolutionary turf amendment product is now on the market in the form of a crumbed rubber top dressing by the name of ìCrown IIIî.

The principal of ìCrown IIIî is relatively straightforward. Applied in 2-3 applications to an eventual thickness of approximately 20mm, the crumbed rubber is worked into the crown area of the turf providing Crown protection and minimizing damage allowing for rapid blade regeneration without the traditional damage to the root zone. But the truly unique thing about this product is that not only do you get this crown protection, but also due to the ideal heat retention in the root zone you get spring growth conditions throughout the winter months along with reduced compaction levels in the soils.

Ideal application areas are driving ranges, golf tees & cart track ends, high traffic areas prone to wear, heavily shaded areas, general areas experiencing difficult turf growth & development.

For Further details please contact Reclaim Industries on 1800 685 454 or visit their website: www.reclaim.com.au

Before - and after

TIM 750 – TURF LAYING SYSTEM

Returfing at Gainsborough Greens GC

Brisbane company Turf Tech Australia is pleased to present a new turf laying system that has been proven and is set to offer real benefit to the Australian Turf Industry.

Designed and developed in the UK, the TIM 750 is a unique machine that is compact, highly maneuverable and extremely efficient. The system is ideal for turfing / returfing work on golf tees, fairways, tennis courts and bowling greens.

For further information please contact James Targett from Turf Tech Australia on 0418 781 830

PrimoMAXX ENHANCES TURFGRASS STRESS TOLERANCE

Primo MAXX is a new formulation plant growth regulator from Syngenta that reduces turfgrass growth by about 50% for 4 or more weeks when applied at label rate. In addition, research projects and use by 1000's of golf courses around the world indicate that turfgrass stress tolerance can be enhanced.

The key factor in using Primo MAXX to help turfgrass become more stress tolerant is to make multiple, repeat applications. In other words, put the turf on a Primo MAXX program. As vertical growth is slowed, growth is redirected to lateral stems (stolons, rhizomes, and tillers) and roots. The turf becomes denser and the leaves become smaller and more compacted. This is especially true for couchgrass.

Also, irrigation requirement may be reduced, due to an improved root system and reduced transpiration (smaller leaves).

Primo MAXX can be safely used on golf putting greens. Superintendents in the U.S. have found that applying Primo MAXX at reduced rates more frequently (ex. – _ the label rate every two weeks) makes the greens more wear tolerant. In addition, speed can be increased. The key is to begin applications a couple weeks after active growth has started, and continue throughout the season. Stop applications if the greens become stressed due to extreme heat, irrigation problems, etc. Primo MAXX can be safely mixed with fungicides, fertilizer, and iron sources.

Primo MAXX can be a valuable tool for superintendents. It will be used for different reasons at different courses. Reduced mowing, fuel cost savings, improved turfgrass quality, reduced equipment wear, safety in hard to mow areas, and improved stress tolerance are key benefits.

For further information regarding Primo MAXX programs, contact your local Nuturf Territory Manager or phone 1800 631 008.

3D LASER CONTROLLED LEVELLING

McMahons have developed a 3D Laser Controlled leveling system that controls the blade on the leveling unit which then creates the required levels from a 3D CAD plan.

As the unit is driving around the green the blade is constantly moving up or down to the required height at that particular point on the green. The blade is not confined to the set plane of a conventional laser controlled level so any undulating surface can be formed.

This concept was first established by Rob McMahon for use at Stadium Australia, and was then used at Colonial Stadium and again at Royal Randwick Racecourse. The accuracy of levels required on these projects was easily achieved in all cases and in a much shorter period of time than by conventional peg and grid systems.

The next challenge for Rob was to develop a machine that could be used on smaller areas such as Golf Greens and achieve the higher accuracy of levels required in that situation. After several trials the first machine was used at Royal Melbourne last October. The accuracy achieved was adequate but all parties believed the system could be improved to produce even closer levels. Further research and development produced the current machine, which is Mark V, built onto a four-wheel drive unit, which achieves the accuracy desired. Six greens have now been reconstructed with a further four scheduled for later this year.


Work at Royal Melbourne GC

The system also has a facility to spot check, anywhere on the green, the accuracy that has been achieved. A data collector fitted to the staff gives an instant digital readout of the current surface level relative to the design level at that point. This allows the superintendent to personally check how work is progressing until the accuracy that is required has been achieved.

Once a green has been surveyed in its existing form it can be reconstructed to the same contours time and time again using this system. If any changes are required to the surface design of the green, it can be drawn onto a new CAD plan and the redesigned green can then be constructed to the new design contours. It also allows the same contours to be re-established at a higher or lower level than before.

This will be of use to clubs who are redeveloping their greens and wish to remove the tops to establish the green in a different turf type or to remove thatch and mat layers and can be used on any surface such as greens, surrounds and fairways where a CAD design has been established..

For further details on this system, please contact Alan Stobbie from McMahons on 0419 306 131.

NEW FROM TURF & IRRIGATION

Turf & Irrigation Pty Ltd, has recently introduced Renomaster and Renomaster Plus into their range of renovation fertilisers.

Renomaster is a blend of sterilised fowl manure and multicote controlled release fertiliser. Alternatively, Renomaster Plus is a blend of sterilised fowl manure, multicote controlled release fertiliser and granulated wetting agent. Both Renomaster & Renomaster Plus are primarily used for Turf Renovation.

Renomaster & Renomaster Plus are ideal for any turf renovation project, whether it be Golf Courses, Sports Turf, Landscaping or Grounds Maintenance.

Renomaster & Renomaster Plus are available in 25Kg Bags from Turf & Irrigation.

Simply call 132 009 for your local showroom.

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GCSAQ

With some good rain in late August things suddenly looked a little brighter for Queensland Golf Courses all along the east coast but the lack of general follow up rain has meant we are all being very conservative with the water and are anticipating more dry weather. Things up in far north Queensland are really drastic with no real wet season at all for the first time in memory, the result of this is extremely dry conditions with even the cane fields dying off. Water restrictions on the Gold Coast have been in place for months now and even the beach showers have been turned off so plenty of smelly tourists are about.

The Annual General Meeting of our association saw no controversial coup or screaming shareholders but we do have two new committee members. Dave Morrison from Hills International School and Chris Goopy from Keperra Golf Club have come on board to help us out and I welcome them and hope they find it a rich and rewarding experience. They join the following people:

President:
Jon Penberthy – *Gainsborough Greens Golf Club*
Vice President:
Barry Cox – *Ocean Shores Golf Club*
Secretary:
Ben Tilley – *Twin Waters Resort*
Treasurer:
Rodney Cook – *The Grand Golf Club*
Education and Research Officer:
Pat Pauli – *Horton Park Golf Club*
Golf Captain:
Graham Sims – *Pacific Golf Club*

I would also like to thank and recognise the efforts of retiring committee members Kelly Hyland from Royal Queensland Golf Club and Jason Adams from Wynnum Golf Club who have contributed over the year.

The AGM was held at Kepperra Country Club and was the venue for our Toro Golf Championships. Toro's man on the spot, Ross Sarrow was on hand to present the trophies to the winners:

A Grade: Ian Black – *Gympie Golf Club*
B Grade: Rod Cook!! – *The Grand Golf Club*
C Grade: Stuart Poole – *Gailes Golf Club*

Ross gave a short presentation and introduced Toro's NSW representative Roger Maher, Toro has been involved for many years with sponsoring this event and once again has generously assisted with the day. The course itself was in champagne condition as usual, thanks to Superintendents Chris Goopy and Keith Johnson who gave an enlightening talk on the history of Kepperra Country Club. Our guest speaker was 'Dr Soil', Dr. Paul Saffigna who spoke on salinity, sodicity and potential acid sulphate soil problems and their solutions and gave a practical video show of some past successful work on the Tweed Bypass to Yelgum.

Upcoming events include the November field day at the new North Lakes, and the fabulous December Christmas party at Wet and Wild the extreme highlight of the social season. The efforts of George Roy from Rosewood Golf Club who has recently retired and Les Austin were recognised at the AGM. Les also made a name for himself on our granite belt tour by purchasing a 20 litre cask of chardonnay, an aggressive little wine best drunk quickly.

Movements around the courses; Stuart Barker leaves Sanctuary Cove after many years of good service to go over the road to Hope Island, Scott McKay leaves Hope Island after a brief stay to go to North Lakes. John Lamprell has also gone to North Lakes. Darren Allen appears and goes to Hope Island. Daryl Edwards returns and is going to Sanctuary Cove Golf Club.

Until next time, best wishes,

Jon Penberthy.
President, GCSAQ

NSWGCSA

As most people will be aware, NSW is in the grip of a severe drought with over 82% of the state officially declared. Water restrictions will be affecting more and more people if decent rains don't come soon. Coupled with this problem, most areas have encountered the most severe frosts for over thirty years. Needless to say not many courses are at their best, and unfortunately this has meant some Superintendents are under pressure from certain sections of their clubs.

It is an occupational hazard that we sometimes have to cope with people who have short memories and no concept of dealing with the majority of nature.

Spring is now here and hopefully those who are "under the gun" at the moment will once again be the "golden haired boys", they were three or four months ago.

Our AGM was held on August 29th at Ryde Parramatta Golf Club and those in attendance were treated to a fine display and discussion on both irrigation and machinery by our sponsors the TORO company. A highlight of the meeting was the elevation to life membership of Reg McLaren; who at 70 years of age was finally recognised for his efforts in the premature years of the Association and went on to give twenty years of service on the Board that included nine years as President, a record not likely to be surpassed. After the meeting some people stayed on to enjoy the fruits of host Super Jeff Phillips and his staff and we tested the challenging re-vamped Ross Watson designed course.
Have a great spring!

Martyn Black
President, NSWGCSA

VGCSA

As most will be aware by now the A.G.C.S.A have lost their CEO Euan Laird who is moving on after 10 years at the helm. It must be said Euan has directed the association from it's early days working as a 1 man band from the store room at the VGA offices to an organization with a professional team worthy of national focus.

On behalf of the V.G.C.S.A I would like to wish Euan all the best for the future and good luck with his endeavors.

Local Meetings
State events have been held in a number of locations recently with the annual Managers / Superintendents day returning to Barwon Heads Golf Club. A full field enjoyed excellent playing conditions but unfortunately in the inaugural Team Challenge the Managers narrowly defeated the Superintendents (Look out next year). The day was completed with lunch and a presentation from Peter Fitzgerald from NMIT and Tony Cashmore on golf design.

Our yearly country meeting was also well attended at Shepperton Golf Club in August, which is a bid to support and encourage the country clubs to participate in the association. The guest speakers for the day were Peter Spencer from Nuturf and Don Loch from Qld Dept of Horticulture who both presented very enlightening topics.

Many thanks to Scanoz, Nuturf and NMIT for supporting the previous two meetings.

The final event for this report was the "Careers Day" promoted by the A.G.C.S.A and V.G.C.S.A. This was formatted to assist individuals to make an informed decision in their bid to attain management roles in the industry. Notable turf managers gave an overview of the paths they have traveled to attain their current status. Going by the positive feed back from many of the audience the day achieved it's aims. Our thank to Richard Forsyth, Peter Frewin, Martin Greenwood and Rob Savedra for their contributions.

Next Superintendents meeting will be held at Flinders GC in October. A number of newly constructed greens will add interest to the day.

Course Superintendent Colin Morrison has been flat out since he arrived there two years ago so take this opportunity to participate in the day and take in the views of this lovely coastal course.

Michael Picken
President, VGCSA

SAGCSA

Well with winter now behind us, all attention turns to the spring renovation season, like so many parts of Australia the rainfall so far this year is well below average, with most areas down by about 50 percent. Lets hope that some good spring rains can top up dams ready for the irrigation season ahead.

Our last super's meeting was held at Flagstaff Hills Golf Club, on August 29th (host Superintendent Gary Day). The day was well supported with 40 people in attendance. Superintendents came from as far a field as Mt Gambier Golf Club (Tim Warren), Balaclava Golf Club (Steve Guyer) and Clare Golf Club (Kevin Clark). A big thankyou to all those who travelled so far to get there.

The day itself was highly successful with nine holes of golf in the morning followed by a course inspection, Gary showing the progress made with his TGR program on the greens and the CT2 couch fairway planting's. During the course inspection Mr Graeme Grant who is currently constructing the clubs new 13th hole, joined the group to talk about the clubs two new holes that he constructed during last summer, this was a very entertaining look at the clubs new holes, with Graeme explaining his philosophies on course design and maintenance.

The day was rounded out with a BBQ lunch at the work sheds and a presentation of golf prizes. Also, Mr Dene Goldsack was presented with a 'life member' jacket in recognition of his untiring thirty year involvement with SAGCSA. In this time he has been President as well as Secretary of the association at different times, congratulations Dene.

Our next meeting will be in mid October at the Blackwood Golf Club with the new washdown, chemical mixing and storage and fuel facility as well as a new sand bay complex recently being completed. There should be something for everybody at the next meeting.

In closing, a date for your diaries is the annual Xmas picnic which will be held at Long Gully Oval at Belair National Park on December 1st this year. This is a great day for the whole family so please support the day.

Peter Harfield
President, SAGCSA.

GCSAWA

Mother Nature has not been kind to us here in the west with very low winter rainfall for the second year running. This will obviously cause a few supers much heartache this coming summer with water restrictions already planned.

Our association recently held its bi-annual conference in August. Margaret River was chosen again as the venue and over 50 delegates enjoyed three days of education and social fraternization.

We were privileged to have many eastern state visitors, in particular Mr Gary Dempsey from New South Wales Golf Club and the AGCSA's Mr John Neylan. Gary presented 2 varied and interesting papers to the audience on his American experiences and his environmental work at NSW with herbicide spraying. John presented the latest news on the bentgrass trials and some interesting information on summer turfgrass stress management. We do appreciate the "DOYENS" of the industry giving up their time to attend our conference. Other local speakers covered many other diverse topics and the feedback from delegates was very positive. The golf championships were held on the Monday at Margaret River Golf Club and congratulations go to John Forest on his Niel Adams Shield victory and Michael Dennis on winning the TORO Cup. The golf course was presented in fantastic condition by Nathan Darch and his two staff, well-done boys! On the Wednesday afternoon a group of thrill seekers ventured down to the cliffs for an exciting session of abseiling. This was enjoyed by all except the wait in the pouring rain for the bus to return us to the hotel. We do extend our thanks to all the sponsors who helped to make this event more affordable to many supers who would not normally attend these types of events.

I would like to take this opportunity of behalf of the GCSAWA to thank Euan Laird for his dedication and hard work over the past ten years. Euan has steered our national association towards bigger and better things and has certainly helped many of us achieve more from this profession. On a personal note, I would like to thank Euan for his direction and assistance at the state presidents meetings that have certainly increased my awareness and appreciation for the work the national association does for the members. Euan we wish you the best, for your future endeavours.

Allan Devlin
President, GCSAWA

TGCSA

The TGCSA has just held a relatively successful 'Mini-Turf Conference' at Archers Manor in Launceston. The two day seminar was well supported by the turf sector in general. Turf Managers from bowls, cricket, golf, parks and recreation came together for a very informative two day event.

The AGCSA organised Technical Officer Andrew Peart to do two presentations; 1. Eco efficiency for turfgrass areas, 2. Bowling Greens Construction. Presentations were also given by Matthew Bywater, Nuturf, Rob Stanic, Simplot, Rod Way and Owen Connelly, Valley Seeds.

A turf tour of Mowbray Golf Club on Sunday afternoon freshened everybody up prior to the dinner Sunday night, which I believe kicked on until the early hours and turned into Chris Hay's Karaoke night!

Our AGM was postponed until late September.

As I will not be renominating, a new President will be elected at the AGM. Thankyou to all members of the TGCSA and the AGCSA Board and Staff for their help and support over the last three years.

Phil Hill
President, TGCSA

TGAA (VIC)

At our recent AGM a number of things occurred

1. Not one question from the floor to our treasurer following his report. With the current scrutiny of many multi national organisations this is a rare occurrence and testimony to the books Bill and Simone keep. Well done to you both.

2. "Club 10" was launched and the members who have been financial for 10 years and over were presented with a TGAA polo shirt with Club 10 under the logo to show they have been committed to their Association. We trust they will be worn with pride and the committee thanks you for your continued involvement.

3. The Zoo proved to be a great venue for our AGM as Abbey discussed the day to day issues she has with the lawns. Some of which you don't learn at trade school. Those giant turtles can cause some damage! Paul gave us an insight to the proposed water recycling initiative the Zoo has on the cards, and Patrick was speaker for the defence regarding his beloved insects and how they are critical to the food chain, even the black beetle.

4. Attendees were privileged to be amongst the first few to see the 2 day old giraffe. Released, as we arrived, to be with its mum in the public enclosure it was surprisingly steady on its feet and rather big for a newborn calf. We thank Abbey for helping us orginise the afternoon.

5. After 4 years as President Rob Savedra stepped down to allow for fresh talent. He thanked his committee members for their commitment and support of him during his terms. He also highlighted introducing Simone to the TGAA as being the best thing he did as President.

6. The committee now stands and congratulations too:

President: Anthony Uhr Henry
Treasurer: Bill Turner
Vice President: Rob Sundblom
Secretary: Ian Beel
Commity: Jim Marchbank, Cameron Henley, Michael Holohan, Alan Stobie, Matt Scott

A fine bunch, ready to serve the members and Sponsors.

The next Event will be held at Holmesglen Institute of TAFE on December 4TH.

Phil Ford and Gary Thomas will be speaking on New Turf Construction Techniques they witnessed whilst touring the United States during October. This was a TAFE funded tour so they are using this forum as one way to spread their findings to all.

Holmesglen will be showing us around their new state of the art building and lecture theatre along with hands on demonstration of the wonderful computer facility.

A BBQ Lunch and Xmas Break up will round out a very successful year for the TGAA (Vic).

On behalf of our members the TGAA would like to wish Euan Laird all the best for the future and wish Scott Bolton a speedy recovery.

Anthony Uhr Henry
President, TGAA (Vic)

TGAA (ACT & Surrounding Region)

In local news, the recently held AGM proved to be an enjoyable occasion for all of those who attended. Although it was planned to host current Wallabies manager Phil Thompson as guest speaker he was unfortunately unable to attend. Committee member Mal Daisley, our resident insider & grounds manager for the ACT Brumbies Rugby Club was able to organise ACT Brumbies player Peter Ryan, former rugby league player for the Brisbane Broncos. Peter spoke of his experience in playing at the elite level in both league & union and gave his views on the future of the different codes. He was certainly an entertaining speaker and was only too pleased to answer any of our questions. Everybody would like to thank Peter for giving his time.

During an open discussion at the AGM much interest was given to the thought of establishing a national Turf Grass Association Seminar which would be held in a different state bi-annually. There is much debate on the idea at this stage & we hope that it will soon be a reality. Recent enthusiasm shown by turfies to be involved with the association has seen an increase in committee members nominated for positions this year. We have always encouraged new ideas & fresh blood into the association.

The recent feedback from those delegates who attended the mid–year seminar have been positive & constructive. We are taking any ideas for improvement on board so please don't hesitate to contact us.

With drought conditions being experienced around the territory it seems that the years are progressively becoming hotter with less rain. The expectations of turf managers to produce high quality playing surfaces are becoming more difficult. With the costs associated with water usage & current pumping restriction it is essential that today's turf managers exercise sound and effective irrigation practices using the correct management techniques. "Water is a valuable resourse, let us not be wasteful". Best of luck to you all over the summer months & keep your eyes out for the latest up to date news & information around the district.

Till next time, agrostologists

Justin A K Haslam
(Committee, TGAA ACT & Surrounding Regions)

VGA

Well another season is upon us by now, everyone should have their greens running tip top for pennant bowls and more than likely we'll be heading for water restrictions. Our seminar / AGM held in August was fairly successful with much debate and interaction on OH&S and our legal requirements.

The committee for 2002-2003 are as follows:

President: Doug Agnew
Immediate Past President: Peter Barron
Vice Presidents: Alan Elliot and Andrew Kent
Secretary: Duncan Knox
Treasurer: David Sharp
Committee: Shane Harling, Darren Martin, Ian Latham, Bill Hemshere, Gary Van Kessel and Greg West.
Match Committee: Alan Elliot, Keith Fleetwood and Adrian Marston.

President: Doug Agnew thanked outgoing members Andrew Ross, Brian Sanders and Peter Rasmussen. He also congratulated Greenkeeper of the Year Darren Martin, Yallourn Bowls Club and Distinguished Service Recipient Len McKenzie, Victoria Bowls Club. He also thanked the Minister for Sport and Recreation Mr Justin Madden for sponsoring the Association and presenting the awards. Doug also thanked Henselite Australia for their sponsorship although Mr Bruce Hensel could not attend as the company was in the process of moving into new premises.

President Doug welcomed the new committee and said he looked forward to another busy year with more research, updating our webpage, continuing to improve our newsletter and in general keeping the general flow of information between turf managers across the state going.

Duncan Knox.
Secretary, VGA

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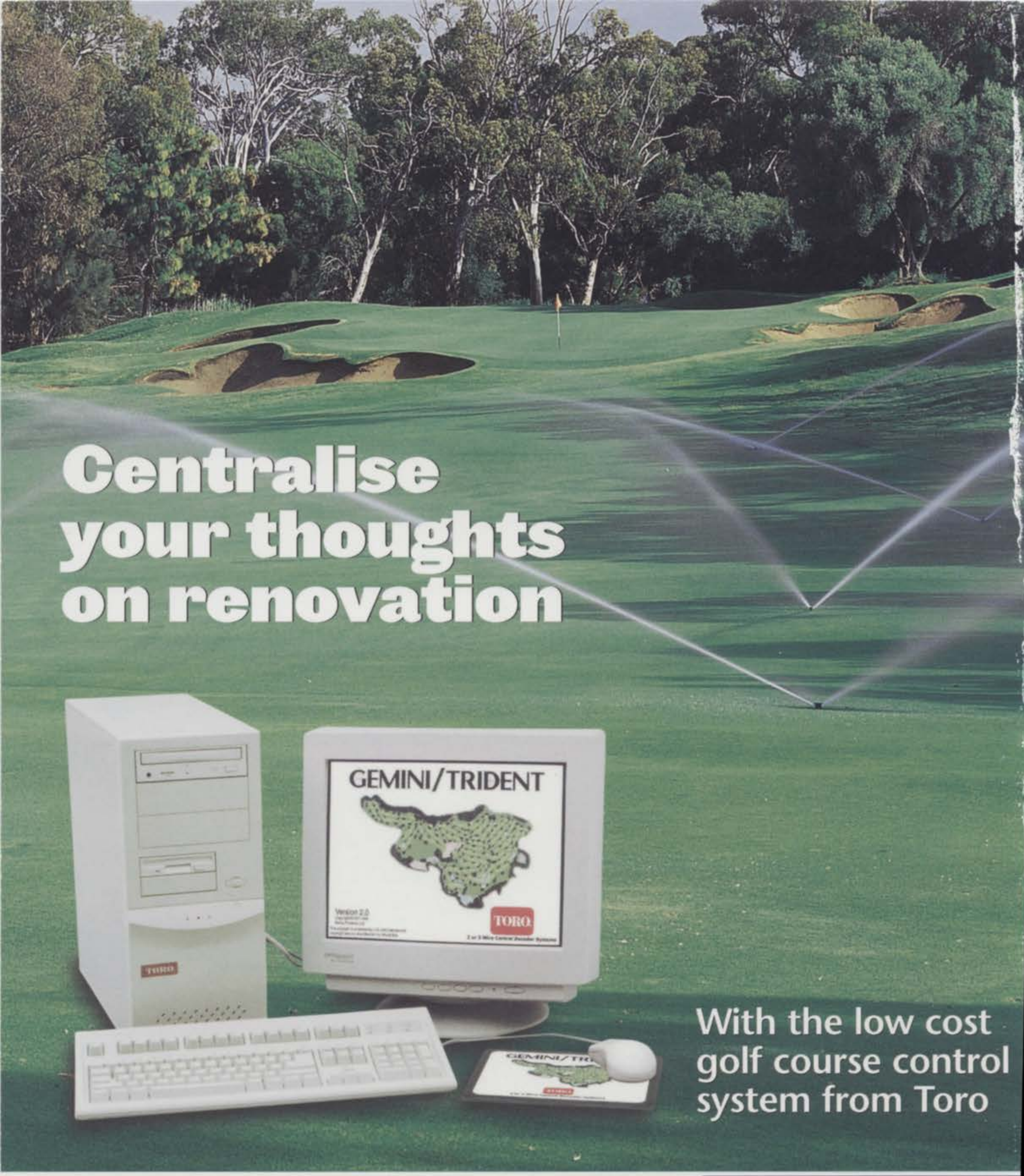
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