Under the Microscope...

Effects of Drought on the Performance of Warm-season Grasses

Zoysia macrantha - highly drought tolerant

Scientists from the Turf Research Group at the Department of Primary Industries and Fisheries in Queensland have been studying ways to conserve water in irrigated parks and gardens. Potential savings of 50 per cent of current water applications were indicated by the trials over three years.

The effects of drought on the performance of warm-season turfgrasses were investigated over three experiments in Brisbane. Information was also collected on water use in sporting fields in Pine Rivers Shire. The main objectives of the project were:

- To study the impacts of drought on the performance of the grasses, and indicate their relative drought tolerance;
- To study the relative water use of tropical turfgrasses;
- To develop irrigation strategies for turfgrass managers;

The major contributors to the irrigation project were Horticulture Australia Limited (HAL), Lensworth and Lend Lease, Jimboomba Turf and Twin View Turf. Pine Rivers Shire Council, Townsville City Council and Calliope Shire Council also collaborated in the various experiments.

Water Use

Cool-season grasses in the USA use 65-80 per cent of the evaporation from a Class A pan evaporimeter, while warm-season species use 55-65 per cent. Average water use varies from 2.5-7.5mm per day, with maximum values as up to 12mm per day.

In Western Australia, the minimum daily irrigation required to maintain the growth and colour of cool-season turfs growing on sand was 80-100 per cent of evaporation, and 50-60 per cent in nine tropical genotypes. The lower irrigation requirement of the tropicals was associated with lower evapotranspiration and deeper roots.

Research on bermudagrass in the USA showed that transpiration in humid regions was 50-60 per cent less than that recorded in arid areas. Bermudagrass had lower transpiration than Japanese lawngrass, and seashore paspalum lower water use than bahiagrass or paspalum.

While variations exist between hybrids of bermudagrass, limited differences have been observed within Japanese lawngrass and buffalograss cultivars. Species with low transpiration generally have low plant water conductance and small leaves.

Drought Tolerance

Variations in drought tolerance have been found amongst different species. Paspalum is more tolerant than bermudagrass and Japanese lawngrass. The relative order of increasing drought tolerance in the USA is carpetgrass < buffalograss < Japanese lawngrass < bermudagrass < bahiagrass. In southern Australia, kikuyu (*Pennisetum clandestinum*) and bermudagrass have excellent drought tolerance, while buffalograss is fair.

Grasses can use various mechanisms to grow and survive a drought. Some species try to avoid the drought for as long as possible by having relatively low rates of water loss or transpiration, or by having deep root systems capable of withdrawing water from the subsoil.

Other plants survive by maintaining photosynthesis and growth at relatively low levels of soil or plant water. Such responses usually involve changes in cell chemistry. Plant adaptations to drought are wide, and usually involve more than one mechanism. The ability of most species to grow during dry weather usually involves both "drought tolerance" and "drought avoidance".

The Research

Drought experiments were conducted on 19 grasses growing in 100 litre bags of sand at Cleveland in Brisbane.

The grasses included *Axonopus compressus* (broad-leaf carpetgrass), *Dactyloctenium australe* (sweet smother), *Paspalum nicorae* (Brunswick grass), *P. notatum* (bahiagrass), *Cynodon dactylon and C. dactylon x C. transvaalensis* (bermudagrass), *Digitaria didactyla* (Queensland blue couch), *Bothriochloa pertusa* (Indian bluegrass), *Stenotaphrum secundatum* (buffalograss), *Zoysia japonica* (Japanese lawngrass), and Australian natives *Pseudoraphis spinescens* (spiny mudgrass), *Sporobolus virginicus* (marine couch), *Themeda triandra* (kangaroo grass) and *Z. macrantha* (prickly couch, native zoysia).

'Wet' plots were watered every three days, while 'dry' plots gradually dried out over several days. Total available plant water in the pots was 50 mm, with the grasses using 2-5 mm per day.

Species were scored on the effects of drought on canopy height and dry matter production, and time taken to wilt and turn brown. Data was also collected on plant water use, plant water content and leaf physiology in selected species.

The Results

Drought-sensitive species wilted and turned brown after about 12 days in summer and after 34 days in winter, whereas drought-hardy plants showed symptoms after 21 days and 45 days (see Table 1). The plants recovered within a week of re-watering, with no signs of permanent injury. Species with high water use under well-watered conditions droughted earlier than those with low transpiration.

There was only a small visible effect of drought after seven or 10 days in summer, with the dry plots two per cent shorter than the wet plots. The only exceptions were Windsor Green, Plateau, Indian bluegrass, bahiagrass and sweet smother where the dry plots were 10 per cent shorter.

Average shoot dry matter production per day was 17 per cent lower in the dry plots (0.88g per plot per day) compared with the wet plots (1.07g per plot per day). Greenlees Park, Wintergreen, Legend, Tifdwarf, buffalograss, marine couch and prickly couch were the least drought sensitive with a relative dry matter production (dry value/wet value) of 0.85 or greater (equivalent to a 15 per cent reduction or less in growth).

Tifgreen and Windsor Green were the most sensitive with a relative dry matter production of 0.6 (equivalent to a 40 per cent reduction in growth) followed by carpetgrass, blue couch, sweet smother and Japanese lawngrass (dry value/wet value of 0.7 or a 30 per cent reduction in growth).

Sweet smother, carpetgrass, Windsor Green and bahiagrass were relatively less drought tolerant (score of 3 or 4 for drought tolerance out of 9); blue couch, Indian bluegrass, Brunswick grass, Japanese lawngrass, Plateau, Tifgreen, kangaroo grass and spiny mudgrass were intermediate (score of 5 or 6); while Greenlees Park, Wintergreen, Legend, Tifdwarf, buffalograss, marine couch and prickly couch (native zoysia) were more drought tolerant (score of 7 or 8).

Total water use for buffalograss during a 12-day drought in summer was 47mm or 4mm per day. During the first few days of the experiment, the crop co-efficient, kc (ETc/ETo) or relative water use was 1.4-1.6, indicating that plant water use (ETc) was greater than potential evapotranspiration (ETo) estimated by the weather data. In other words, the turf was over-watered.

At the end of the experiment, plant water use was only 50 per cent of potential evapotranspiration. A similar analysis in blue couch showed that kc declined from 1.2 in wet soil on day one to 0.2 in dry soil on day 12. This species had lower relative water use than buffalograss under both irrigation and drought.

Droughted plants had lower relative leaf water contents (RWCs) and higher leaf temperatures towards the end of the experiments. This is because water evaporates from the leaf surface and cools the plant.

Differences in water content between the well-watered and droughted plants did not translate into large differences in canopy height (see above). In other words, shoot extension was not affected by the drought until the plants wilted.

In the pot experiments, plant water use declined when the grasses had used about 30 per cent of the water available in the sand. This value extended to 50 per cent in a clay loam in the field (see Figure 1).

Implications

The results show that there would be difficulties growing most of the species in dry areas in northern Australia, without supplementary watering. Broad-leaf carpetgrass and sweet smother were relatively drought sensitive, while marine and sand couch were relatively drought tolerant. Bermudagrass, blue couch and buffalograss were intermediate.

The grasses growing in sand with well-developed roots did not show symptoms of drought for two to three weeks in summer and for four to six weeks in winter.

Average water use ranged from 1-2mm per day during the cooler months to 3-4mm per day during summer. Most of the species extracted soil water to 75 cm or below in the sand (pot experiments) or clay loam (field experiments). There was no loss of turf quality with a long irrigation cycle (weekly), suggesting that many turf managers are over-watering.

Water use varied by a factor of two with the different species and irrigation cycles, indicating potential savings to park managers.

	Days to wilt and turn brown		Relative water content (%)		Difference between leaf and air temperature (°C)		Relative canopy height (dry/wet)	Relative dry matter production (dry/wet)
	Winter	Summer	Wet	Dry	Wet	Dry		
Brunswick grass	12-14	34-39	95	76	-0.3	7.1	0.90	0.79
Bermudagrass	13-17	39-45	91	71	0.2	6.3	1.07	1.19
Buffalograss	13-18	39-45	95	80	-1.5	6.1	0.99	0.92
Common blue couch	15-18	>45	95	70	1.0	5.2	1.08	0.74
'Aussieblue'	14-19	>45	93	64	0.4	11.4	-	-
Marine couch	13-19	>45	89	68	5.1	11.0	1.06	1.14

Table 1. The effects of drought on tropical grasses at Cleveland. Relative canopy height is final height of dry plants/final height of wet plants. Relative dry matter production is daily dry matter production of the dry plants/daily dry matter production of the wet plants.

Australian National Turfgrass Evaluation Program (ANTEP)

research

MICHAEL ROBINSON

The tall fescue plots at Government House in Canberra. The trials include examining the performance of tall fescue under dryland conditions.

Michael Robinson from SportsTurf Consultants outlines two research projects the organisation is conducting.

Horticulture Australia

Tall fescue *(Festuca arundinacea)* is one of the most drought tolerant cool-season turfgrasses available and is used in sportsfields, racetracks, passive recreational areas, home lawns and is also an important component of seed mixes. It is primarily grown along the south eastern seaboard of Australia (South Australia, Tasmania, Victoria and the lower half of New South Wales).

The ANTEP tall fescue trial is following a similar protocol to the perennial ryegrass trials which concluded in December 2000 (see Australian Turfgrass Management, Vol 3.1 - Feb/Mar 2001) but is also examining the performance of tall fescue under dryland conditions.

The two trial sites are located at Government House in Canberra and Chisholm TAFE at Rosebud on Victoria's Mornington Peninsula. There are 22 tall fescue varieties (including Demeter tall fescue) under trial. For comparison purposes four fine fescue varieties (Victory II Chewings fescue, Spartan hard fescue, Jasper creeping red fescue and Azay sheep fescue) and Victorian perennial ryegrass have been included.

At each trial site there are 432 plots under evaluation (27 turfgrasses, by two mowing heights by two irrigation regimes by four replicates).

Trial maintenance is based on a low to moderate level of nutrition and there are two mowing height treatments, 20mm and 40mm. The irrigated trial is irrigated to prevent wilt and the dryland trial was only irrigated during establishment.

The trials were set up in 2002 and were assessed during establishment for seedling vigour and rate of cover. Once full cover was attained quarterly assessment of colour, density, shredding and seasonal growth commenced. Full sward assessments are undertaken for a period of two years and the trial will finish early next year.

Full results will be available on the Seed Industry Association of Australia's web site (www.sia.asn.au) after the two years of assessment are completed. Field days are planned for both sites later in this year.

This trial is funded by the Seed Industry Association of Australia with matching funds provided by Horticulture Australia Limited.

Rhizoctonia Control Project

The Victorian Greenkeepers Association, in conjunction with Sport Victoria, commissioned a research project to investigate the incidence and control of Rhizoctonia patch in bentgrass bowling greens. This disease has been shown to be a significant problem in the preparation and provision of fast-running bowling surfaces.

The project has involved surveying Victorian greenkeepers to establish the nature of their greens in terms of soil type, grass type, incidence of disease, cultural procedures used in maintaining the greens and success or otherwise in controlling the disease.

Two field trials have been conducted to determine the efficacy of chemical control. One trial investigated the use of a range of fungicides as a curative application, while the second trial investigated the use of fungicides as a preventative application at renovation of the green.

Final assessment and reporting is in progress.

TRANSITIONAL RYEGRASS TRIALS

David Nickson, together with the TGAA Victoria and the City of Dandenong, is in the process of conducting a 12 month trial of transitional ryegrasses in Melbourne.

Couch and kikuyu will be the base grasses as it is anticipated that there will be different results from each species.

Three or four transitional ryegrasses – a turf type perennial ryegrass selected from the recent AUSTEP trial, a semi-pasture type ryegrass and possibly an annual type ryegrass will constitute the treatments as well as a non-overseeded control. Each plot measures 4x2m with four replicates set out on a randomised block design.

The plots were established at a time that gave the ryegrass a chance to establish before subjected to winter sport wear.

At the end of the winter sport season, Nickson will spray out half of each plot and monitor and measure the couch and kikuyu cover in each treatment and also record the time it takes for each treatment to reach 90-100 per cent cover from the warm-season grass.

The remaining overseeded areas will be monitored to determine if the transitional grasses thin out and, if so, by how much. During late summer it is envisaged the remainder of the plots will be sprayed and warm-season grass coverage recorded compared to the sections sprayed earlier and the control plot.

Nickson is also hoping to start a grass variety trial for racing in southern Victoria over the next couple of months. Nickson was also heavily involved in research with Phillip Ford into the use of entomopathogenic nematodes for the control of Winter Corby grubs and the VGA turf trials (See Ford's report on Page 10-11).