OPTIMAL WATER USE OF TURF GRASS

EXECUTIVE SUMMARY

Rationale

Estimation of water requirements for turf grass used in South Africa is of utmost importance for irrigation scheduling on sports fields. This is very important as South Africa is prone to water shortages. In urban environments water treated to potable standards is often used for irrigation and over- irrigation of sports fields causes wastage of this precious commodity. Currently irrigation on most of the sports fields in South Africa is according to the feeling of the superintendent and is considered an art rather than a skill based on scientific knowledge. Many golf greens are over-watered and irrigation applied at the wrong times of the day. It would be of cardinal importance to develop some means of estimating the rate of water use to assist in proper irrigation scheduling which is sparing in its use of water, affordable and user-friendly to sports facilities.

Objectives

The overall objective of this study was to measure evapotranspiration rates of turf grasses used in South Africa and to establish so-called crop factors which relate water usage of turf to a convenient measure of potential evaporation. A preferred means of obtaining potential evaporation measurements was with a Class-A evaporation pan. Data from an automated weather station was also considered to be of benefit in enabling the sport facilities country-wide to apply the results of these investigations. It was also necessary for crop factors to reflect the influence of cultural practices such as mowing height and fertilization which play a major role in turf grass water use.

Methodology

Evapotranspiration was measured with the aid of weighing lysimeters in a field of well-maintained turf grass located at Potchefstroom University. Six different turf grasses were evaluated according

to their response to mowing height and fertilization. These included one cool-season grass and five warm-season grasses. **Penncross Creeping Bent** (*Agrostis pulastris Huds.*) was used as the cool-season grass while the following warm-season grasses were evaluated : **Numex Sahara** (*Cynodon dactylon* (L.) Pers.), Kikuyu (*Pennisetum clandestinum* Hochst ex Chiov.), **Bayview** (*Cynodon transvaalensis* Burtt-Davy), **Speedy Royal** (*Cynodon dactylon* (L.) Pers.), and **Florida** (*Cynodon transvaalensis* Burtt-Davy).

Results

1. *Water use of Bermuda grasses*

Four Bermuda grasses were evaluated in this study, of which two belong to the *Cynodon dactylon* species and two to the *Cynodon transvaalensis* species. Numex Sahara grass which belongs to the *Cynodon dactylon* species, had the lowest ET rate of all the grasses evaluated. The average ET of the grass was found to be 3.95 $mmday^{-1}$ and it had a crop factor of 0.69. Florida grass, which is a strain of *Cynodon transvaalensis*, was the grass that had the second lowest ET rate of these grasses. The average ET rate of this grass was found to be 3.99 $mmday^{-1}$ with a crop factor of 0.70. Speedy Royal, another *Cynodon dactylon*, followed with an average ET of 4.23 $mmday^{-1}$ and had a CF of 0.75. Bayview is the Bermuda grass with the highest water use rate with an average ET of 4.29 $mmday^{-1}$ and a crop factor of 0.76.

Evapotranspiration rates of Bermuda grasses ranged from 1.32 to 8.81 $mmday^{-1}$. A broad range of canopy structure, shoot density, leaf area and vertical leaf extension rate exists among the commercially available Bermuda grass cultivars. In comparisons among cultivars, higher nitrogen levels tended to have a stronger effect on increasing ET rate than a higher mowing height with the ranges used. This response is probably associated with the enhanced vertical leaf extension rate associated with higher N applications.

The fact that Bayview grass used considerably more water than Florida grass, could probably be explained by its deeper green colour which reflects less energy in visible wavelengths, its more vigorous growth and its higher root mass. It could also be due to the high potential of this grass to thatch. Bayview comes out dormancy faster than the other *Cynodon* spp. and cultivars considered and takes longer to reach dormancy in the winter. It thus has a longer growing season, which leads to an increase in the average ET rate.

The *Cynodon dactylon* spp. have a broader leaf texture than the *Cynodon transvaalensis* spp. This creates a relatively open canopy more conducive to convective air flow. This leads to a higher water use rate. An increase in mowing height causes an increase in water use for much the same reason.

In this study it was found that Bermuda grass can use up to 8.81 $mmday^{-1}$. At this maximum level of water use, the crop factor is 0.95. It must be remembered that this study was conducted under non-limiting water conditions and the N levels were very high. It is believed that the use of average ET rates and crop factors for irrigation scheduling would be more realistic than the use of maximum rates.

2. *Water use of Kikuyu grass*

Kikuyu grass used the most water of all the turf grasses evaluated. The average ET of Kikuyu grass in these tests was 4.41 $mmday^{-1}$, with a crop factor of 0.78. The maximum ET of Kikuyu grass was found to be 8.66 $mmday^{-1}$ with a crop factor of 0.97.

This is a very high crop factor for a warm season grass. The high potential ET rates of Kikuyu under non-limiting soil water conditions are possibly due to its rapid vertical leaf extension rate and high leaf area, plus its reduced horizontal leaf orientation. This is essentially similar to the explanation given for the higher water use rate of the *Cynodon dactylons*.

3. *Water use of Creeping Bent grass*

Penncross Creeping Bent grass has a potential ET of 7.9 to 9.7 $mmday^{-1}$ in summer months. Creeping Bent grass is a vigorous grass with fairly rapid vertical leaf extension rate. In this study the Creeping Bent grass had an average ET rate of 4.21 $mmday^{-1}$ and a crop factor of 0.75. The maximum ET recorded in this study was 8.17 mmday^{-1} with a crop factor of 1.22. This is unrealistically high and could only be explained by the non-limiting conditions or a measurement error.

4. *Effect of mowing height on turf grass water use*

This study confirmed the fact that increase in mowing height will lead to an increase in water use of turf grass. Turf grown at 8 mm used 10% more water when compared with turf grown at 4 mm. Tall grass transpires more than short grass since, while no more solar radiation is intercepted per unit area, more advective energy can be intercepted. This has an implication for golf greens where the apron is grown at a higher mowing height than the rest of the green and, therefore, subjected to localized drying. A recommendation based on the results of this study would be to remove the apron and mow all the Bent grass to the same height of 4 mm. The Kikuyu grass that is usually used as fairway grass can be mowed shorter to 8 mm to surround the green. Kikuyu grass mown to 8 mm uses approximately the amount of water as Bent grass mown to 4 mm.

The fact that an increase in mowing height leads to an increase in water use of turf grass does not necessarily mean that the average mowing height of turf grasses should be reduced to conserve water. It would be impossible to reduce the mowing height of certain grasses. Several of the tall-type cool-season grasses (Tall Fescues and Rye grasses), for instance, would not survive when mowed too short. It is also a known fact that there is no relationship between drought tolerance and water use efficiency of turf grass. The longer the turf, the more drought tolerant it is. Frequent mowing to a height that will not affect the turf detrimentally will, undoubtedly, promote water conservation.

To conserve water, it is thus recommended to increase the frequency of mowing rather than to reduce mowing height drastically.

5. *Effect of fertilizer application on water use of turf grass*

Increasing the amount of Nitrogen applied will lead to an increase of water use. Overall, the turf grass used 11% more water when the N was increased from two applications of 20 kg.ha^{-1} mo^{-1} to 2 applications of 30 kg.ha^{-1} mo^{-1}. The grass also used 9% more water when two applications of 30 kg.ha^{-1} mo^{-1} was given instead of one application of 60 kg.ha^{-1} mo^{-1}. The turf grass used less water at two applications of 20 kg.ha^{-1} mo^{-1}.

It is thus recommended to apply small quantities of fertilizer (especially N) more frequently.

Conclusions

It is concluded thus that frequent mowing and frequent fertilization with small quantities of fertiliser should be used to reduce water use of turf grass. From this research it became evident that Florida grass uses the least amount of water and Kikuyu grass has the highest water use rate (see Table). Average crop factors arrived at in this report are recommended for use with the respective mowing heights as a guideline when irrigating. The crop factors should be considered as making allowance for the maximum water use rate of these turf grasses. If warm season grasses are irrigated at 60% of the crop factor, no considerable loss in quality will occur. Cool-season grasses should, however, not be irrigated at less than 80% of these crop factors.

Average Crop Factors of Several Turf grasses

Mowing Height (mm)	4	6	8	10	12	**Average**
Turf grass Type			Crop Factors			
Numex Sahara		0.64	0.70	0.74		0.69
Creeping Bent	0.69	0.75	0.79			0.74
Kikuyu			0.73	0.79	0.82	0.78
Bayview	0.71	0.75	0.83			0.76
Speedy Royal		0.70	0.75	0.79		0.75
Florida	0.65	0.72	0.74			0.70
Average	0.68	0.71	0.76	0.77	0.82	0.74

Technology Transfer

Results of this research have already been adopted in practice at several golf courses in the Witwatersrand area where the crop factor of Creeping Bent at a 4 mm mowing height and fertilisation at the rate of 2x20 kg N per month is being used for irrigation scheduling. No decrease in turf quality has occurred and the practice has led to a saving in water use which is still being quantified. Practical application of findings for Kikuyu has, in addition, led to an increase in the quality of turf grass.

Several other golf courses will be encouraged to apply the crop factors in their irrigation planning and Class A evaporative pans will be installed at these locations. For the moment, the individual courses will be making use of Class A pan figures supplied by the Weather Bureau.

The fact that automatic weather stations are so expensive in South Africa will restrict the use of real time weather data for sports field irrigation scheduling. The use of such equipment and data would, nevertheless, be fundamentally sounder than the use of evaporation pans, which are prone to large errors if not sited properly. Consequently, further research is needed to relate automatic weather station data to measured ET data, thereby further refining irrigation scheduling technology for turf grass applications.

Recommendations

Turf grass water use is a complex interaction of atmospheric, plant and soil phenomena and cultural management practices. Investigations in one of these areas generally require control of the others. These restraints generally make an unreal scenario for complete explanation of mechanisms incurred in drought or water use related research, especially under field conditions.

The degree of available soil water for turf varies considerably, and conditions will differ for the researchers studying potential water use, restricted water use, survival of turf grass and drought tolerance of turf grass.

More research is needed to explain the relationship if any, between water use efficiency and drought tolerance. It is often being said that a grass with a high drought tolerance is not necessarily a turf grass with a low water requirement.

Research is needed to relate physiological responses associated with water use, coupled with better understanding of morphological parameters that affects water use rate.

Probably the most needed research on water use of turf grass will be the effect of elements other than nitrogen and their interactions on water use.

The current study only evaluated one cool-season grass, Penncross Creeping Bent grass, due to the fact that when the study was initiated it was the most widely used cool-season grass in South Africa. Since then, many rugby and soccer fields have started to use perennial cool-season grasses such as Tall Fescues and Rye grasses. It would be important to establish the crop factors of these grasses as well.

In proposing a plan for future research on turf grass water use, the first phase should be to establish ET values and corresponding crop factors at an interspecies level with non-limiting water supplies. The same study should, therefore, be undertaken under water-stressed conditions.

The second phase should be the development of ET rates and crop factors at an intraspecies level at both non-limiting water and deficit irrigation supplies. As soon as this has been accomplished, methods of water saving can be incorporated. Resistance to ET should be the major part of this study which would include other factors such as root development and growing media. The final phase of this research should be the development of cultural practices which will ensure a decrease in water use of turf grass. Factors such as optimal mowing height, mowing frequency, amount, type and timing of fertilization, irrigation scheduling, growth regulators, anti-transpirants, species selection and plant breeding should be investigated.

The knowledge gained with this project is a useful starting point for follow-up projects to develop computer programs for the irrigation scheduling and management of sports fields in South Africa.