Microenvironment Effects on Putting Green Quality

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INTRODUCTION

The objectives of this research are two-fold. First is determination of how different intensities of shading and reductions in airflow alter putting green quality. The second objective is to determine the extent to which putting green root zone mix composition and cultural practices alter the adverse effects of shade and restricted air flow on putting green quality.

Results obtained in 1999 showed that increasing intensities of shading and decreasing air flow markedly altered disease severity, development of localized dry spot, and putting green traffic tolerance. The latter was attributed to accentuated bentgrass shoot growth rates and produc-tion of more succulent tissue. This observation led to introduction of two new cultural prac-tices in 2000. The plots were outfitted with a new irrigation system that allowed irrigation at rats corresponding to 100, 80, 60, and 40% of evapotranspiration. Second, the growth regulator, Primo, was applied in an effort to slow shoot growth and decrease tissue moisture content.

METHODS

The experiment site consists of four blocks of ten 8 ft x 8 ft putting greens with different root zone mix compositions. Three of the blocks are covered with shade cloths rated to reduce solar radiation by 32, 51, and 70%. Plastic fence is used to block wind from two, three, or four sides of different blocks. Each block is instrumented for measurement of solar radiation, air and soil temperatures, relative humidity and, for a single root zone mix, soil volumetric moisture content at a soil depth of 2 inches.

The creeping bentgrass on the site is an 8-year-old stand of ‘Penncross’. Mowing was 5 to 6 days per week at 0.156 inch. Irrigation was daily, except then rainfall before 7:00 am was 0.25 inch or more. Fungicides were applied primarily on a curative basis. Primo was applied monthly at 0.25 oz/M to the shaded plots. Fertilization for the season totaled 2.9 lb N, 0.35 lb P_2O_5, and 2.6 lb K_2O.

OBSERVATIONS

The four microenvironments created with shade cloths and wind screens had the character-istics given in Table 1. Figure 1 summarizes for the 1999 and 2000 season the changes in microclimate, evapotranspiration, bentgrass shoot and root growth, disease severity and traffic tolerance that occurred when going from the most favorable microenvironment “A” to the least favorable, microenvironment “D”. Microenvironments “B” and “C” (Table 1) resulted in responses intermediate to those between the A and D microenvironments.

While the differences in air and soil temperature and relative humidity (Fig. 1) seem small, these area season average values. Their cumulative effects are much greater than suggested by these averages. For example, over 10 weeks the turf in microenvironment A had 250 more heat units than in microenvironment D. Also, on a given day and time of day, differences in temperatures approached 10^{o}F or more and relative humidity varied by as much as 12%.

Table 1. Season means for solar radiation, wind speed, temperatures, and relative humidity in the four microenvironments.

Microenvironments	Solar radiation	Wind speed	Temperature Air	Temperature Soil	Relative humidity
	W M^{-2}	mph	------- ^{o}F	-------	%
A	186	3.8	75.2	72.3	85
B	140	2.4	73.2	70.7	84
C	78	1.7	71.6	70.5	86
D	62	1.6	71.5	59.3	87

With the differences in solar radiation, temperatures, relative humidity, and wind speed created, the turfgrass evapotranspiration decreased an average of 58% in going from microenvironment A to D (Fig. 1). Hence, if turfgrass is irrigated at 100% of plant ET in microenvironment A, irrigation needs to be at 58% of ET in microenvironment D to provide equivalent amounts of water and not over-irrigate. We arbitrarily irrigated the greens in microenvironment D at 50% of the rate in microenvironment A. Localized dry spot developed on some greens in microenvironment A but not in D.

Shading stimulated bentgrass shoot growth, resulting in a 47% increase in clipping production (Fig. 1). This accounts for the 33% reduction in rooting depth and 55% reduction in root mass that was observed.

Accompanying the stimulation of shoot growth by shade was a 19% increase in shoot water content. This production of more succulent shoots is thought to be the major reason why physical damage from simulated golf traffic was 70% greater in the most intensely shaded microenvironment.

Shading, restricted air flow, and their effects on air and soil temperatures and relative humidity had dramatic effects on disease severity. In going from microenvironment A to D, the severity of Microdochium patch increased 408% (Fig. 1). There were effects on dollar spot as well, but severity of this disease did not increase proportionally to the reductions in shading and air flow. Rather, dollar spot increased 65% in going from microenvironment A to C, but in going from C to D, severity of the disease declined by 98%. This happened in1999 as well as 2000.

The only explanation offered for this is that one or more properties of microenvironment D are not conducive to growth of the causative pathogen.

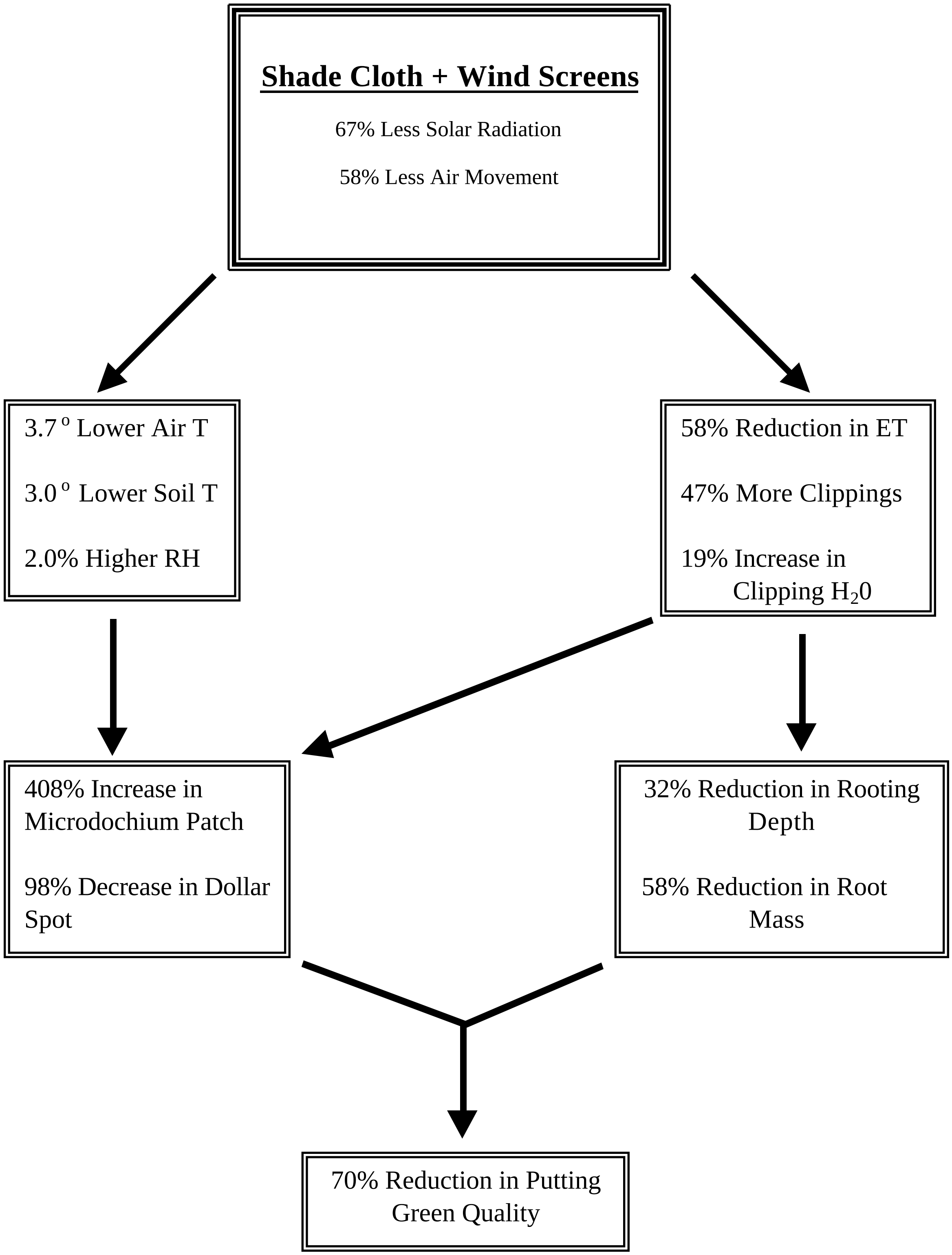

Figure 1: Influences of shading and airflow reduction on putting green quality.

Primo was applied to the shaded plots with the thoughts that bentgrass shoot growth would be reduced and the shoots would be less succulent, the net results being better root growth and less injury due to traffic. Application of the growth regulator reduced shoot growth by amounts that were proportional to the amount of shade. A 6% reduction occurred under 32% shade. This increased to 23% under 51% shade and 43% under 70% shade. Primo applica-tion did not alter the moisture content of the shoots. Perhaps this is why shoot damage due to simulated golf traffic was no different than in 1999 when Primo was not applied.

A second cultural practice implemented this year was adjustment of irrigation rates according to the degree of shading. The assumption was that this would improve turf quality through influences on shoot growth rates and succulence, disease severity, and traffic damage. The full-sum microenvironment A was irrigated daily at the rate of 0.20 inch. Microenvironments B, C, and D received 80, 60, and 40%, respectively, of this amount. In other words, the daily irrigation rates were 0.20, 0.16, 0.12, and 0.08 inch per day except during times of rainfall. These different irrigation rates had no perceptible influences on bentgrass shoot growth and moisture content, disease severity, or the extent of damage due to traffic.

A third "cultural practice" built into the study is root zone mix composition. The primary distinguishing feature of the different mixes is water holding capacity. This ranges from 9.0% water by volume for Greesmix sand blended with fermented rice hulls to 18.7% water retained for Lycon sand blended with Canadian sphagnum peat.

To establish the effects of the different root zone mixes on putting green characteristics and quality in the four microenvironments, I examined relationships between the water holding capacities of the root zone mixes and measures of bentgrass growth and putting green quality. The most notable relationship was that between root zone mix water holding capacity and the increase in bentgrass clipping weights that occurred as a result of shading (Fig. 2). As shown, increases in clipping weights were highest for the root zone mixes with the lowest water retention capacities. This relationship coincides with the occurrence of localized dry spot. Greens constructed with root zone mixes that retained 12% or less water suffered from extensive localized dry spot under full sun, but the problem gradually disappeared as the ET rate declined due to increasing amounts of shading. This prevented drying out of the putting green surface, which is the precursor to development of localized dry spot.

Other significant relationships were those between root zone moisture holding capacity and bentgrass rooting depth or putting green quality when no traffic was applied. Increasing moisture retention capacity decreased the reductions in rooting depth that resulted from shading and improved putting green quality when no traffic was applied. The improvement in putting green quality came about primarily as a result of the influence of root zone moisture retention on the occurrence of localized dry spot.

Root zone mix water holding capacity had no apparent influence on reductions in bentgrass root mass, disease severity nor on the extent of damage from simulated golf traffic as

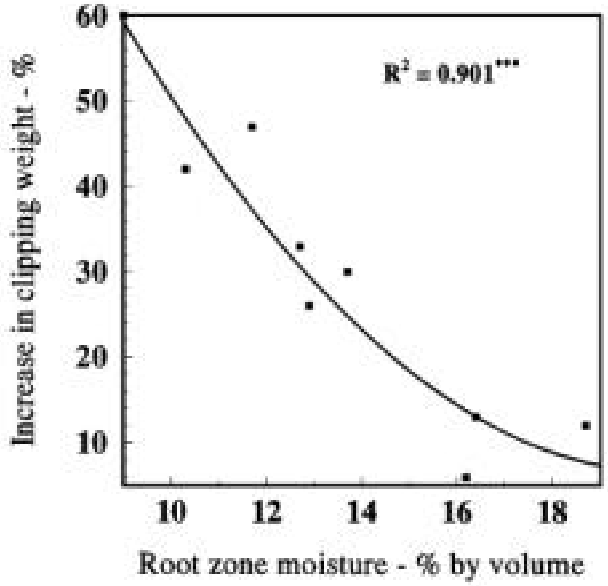

Fig.2. Influence of root zone moisture content on the increase in bentgrass clipping weight due to shading.

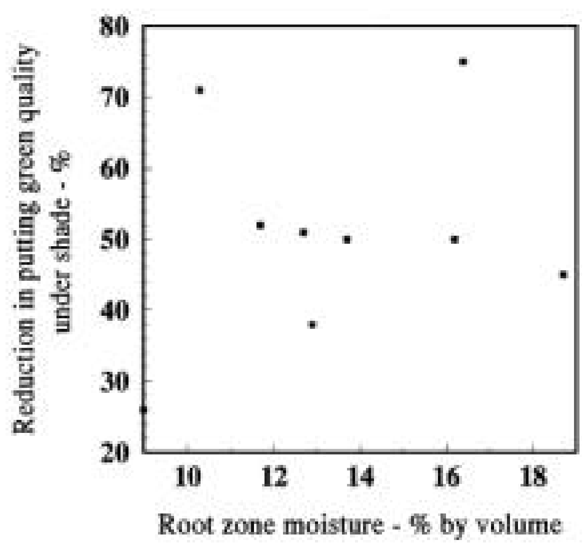

Fig.3. Influence of root zone moisture on the reduction in shaded putting green quality due to traffic.

influenced by degree of shading (Fig. 3). Thus, in the final analysis, varying root zone mix composition did not offset the adverse effects of the microenvironments on putting green quality.

CONCLUSIONS

Shading and restrictions in air flow adversely affect putting green quality through stimulation of more succulent shoot growth that reduces traffic tolerance and through greater disease severity. The only positive effect of shading is elimination of localized dry spot in putting greens whose root mixes have moisture retention capacities of 12% or less by volume.

Application of Primo to shaded putting greens to reduce bentgrass shoot growth or reductions in irrigation rates that coincide with decreases in ET rates are not effective in offsetting the adverse effects of microenvironments on putting green quality. The same holds true for employment of different root zone mixes in putting greens.

Maintaining high-quality putting greens in heavily shaded microenvironments with restricted air flow may be possible, but not through use of common cultural practices. The only realistic and lasting solution is not to locate putting greens in such microenvironments.