Creeping Bentgrass Responses to Water Absorbing Polymers in Simulated Golf Greens

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EDITOR'S NOTE: Tom has just completed his junior year in the Turf and Grounds Management Program. He has been awarded a Wisconsin Turfgrass Association scholarship for the 1990-91 school year.

Introduction

The 1990's are upon us, and the concern over water use is greater than ever. The marketing of soil polymers to increase the water holding capacity of the soil, as well as improving other aspects of turf, is increasing. The effects of these soil chemical conditioners on turf have not been well researched. The bulk of the research that has been done with these water absorbing polymers has not been tied to turf directly; rather, their effects on the transplanting of trees and shrubs, as well as agriculture crops have been studied rather extensively (e.g. Tatter, 1989; Baasiri, et. al. 1986. Wallace, 1987. Callaghan, et. al. 1988). It is from this type of research that inferences have been made regarding use for turf.

Literature Review

Claims made by soil polymer manufacturers include: 1) improved germination; 2) faster root development and more vigorous plant growth; 3) stronger and healthier roots; 4) reduced water consumption; 5) improved aeration and drainage; and 6) reduced fertilizer loss through leaching.

The results of what little research that has been done on turf by scientists independently of the companies that are developing these polymers have not been favorable. For example, one study examined the effects of several chemical soil conditioners on the moisture and nutrient retention capacities of sandy soils, and on the growth and quality of Manhattan perennial ryegrass (*Lolium perrenne* L.) and 'Penncross' creeping bentgrass (*Agrostis palustris* Huds.). From their study, the researchers concluded that "Under conditions of the studies, where sandy soils were subjected to compaction, chemical soil conditioners used did not beneficially affect soil physical properties, CEC, or turfgrass growth. In some instances the influence was detrimental to turfgrass quality and growth." (McGuire, et. al. 1978)

Objectives

Due to the lack of information on the influences of these polymers on turf I decided to research these water absorbing polymers for my Soils 299/Independent Study under the direction of Dr. Wayne R. Kussow. The objectives of this study were to examine the influences of water absorbing polymers on the establishment and growth of 'Penncross' creeping bentgrass in simulated putting greens. More specifically, we were interested in seeing if these polymers actually improve germination rates, produce more vigorous plant growth, promote stronger, healthier root systems and decrease the need for irrigation.

Methods

This study occurred under greenhouse conditions, with USGA-type greens constructed in a 6-inch diameter pipe. The rooting media was 12 inches of a 90:10 greens mix blended from Waupaca sand and reed sedge peat and amended with N, P, K and a micronutrient mixture. The greens were initially seeded at a one pound rate and then overseeded one month later at the one pound rate with 'Penncross' creeping bentgrass. Prior to the initial seeding, the top 3 inches of the greens mix was amended with 19-26-5 starter fertilizer at the rate of 1 lb. N/M. Polymers at the rate of 1 lb./100 ft^2 were then incorporated into this same soil volume. One green received no polymer and served as the control treatment in the study. The polymers tested were (1) Super Sorb F; (2) Terra Sorb HB; (3) StaWet; (4) Soil Moist and (5) Super Slurper. Super Sorb F, Terra Sorb and Soil Moist are polyacrilamide products. StaWet and Super Slurper are hydrolyzed, cross-linked starch polymers. A concern with these starch polymers is that they will break down quicker than the synthetic polyacrylamides. Actually, the lifetimes of none of these products are known with certainty.

Results and Discussion

The ability of polymers to improve the moisture relations of USGA sand-based greens depends on the moisture holding capacities and release characteristics of the polymers. Partial characterization of the water holding properties of the materials used in this study was accomplished by way of a hanging column apparatus that allowed determination of moisture retention at tensions ranging from 0 to 70 cm.

As shown in Table 1, the polymers retained considerably more water than the reed sedge peat but vary widely in this regard. The moisture retention figures for 40 cm. tension are particularly relevant because these approximate moisture held in the top few inches of a USGA-type green after drainage has ceased.

TABLE 1. MOISTURE HOLDING AND RELEASE CHARACTERISTICS OF THE POLYMERS, SAND, PEAT AND THE 90:10 MIX EMPLOYED IN THIS STUDY.

Material	Moisture Content		Moisture released in going from 40 to 70 cm tension	
	0 cm. tension	40 cm. tension		
	Percent by weight		Percent	ML/g
Super Sorb F	17,135.0	16,156.0	3.82	6.17
Terra Sorb HB	36,278.0	32,028.0	4.60	14.73
StaWet	5.732.0	4,572.0	8.72	3.99
Soil Moist	1,564.0	1,338.0	12.00	1.61
Super Slurper	13,875.0	10,125.0	7.61	7.70
Waupaca Sand	26.1	22.5	82.30	0.18
Reed Sledge Peat	491.0	451.0	23.70	1.07
90:10 Mix	32.4	17.3	65.50	0.11

Perhaps the most significant data in Table 1 is the ML water released per gram of material when tension was increased from 40 to 70 cm. This is a measure of the amount of water released as the moisture in the sand-peat mix is reduced to a level where turfgrass begins to undergo strong moisture stress. As shown, there was considerable variation among the polymers in the amounts of moisture released over this tension change. For example, Terra Sorb HB released more than nine times as much water as did Soil Moist.

TABLE 2.
EFFECT OF POLYMERS ON BENTGRASS EMERGENCE AND STAND DENSITY.

Polymer	Plant Counts After 3 days	Average Density Rankings*
	#/green	
Super Sorb F	14	1.6
Terra Sorb	5	5.6
StaWet	23	2.3
Soil Moist	11	5.3
Super Slurper	9	3.4
None	11	2.9

*Rankings: 1 = Highest ranking, 6 = Lowest.
Averages for 7 different dates.

To examine what effect the polymers had on germination and turf density, a seedling count was made shortly after germination and the greens were visually ranked for turf density throughout the semester. Seedling counts four days after seeding shows that, compared to the control treatment, Terra Sorb had an inhibitory effect (Table 2). Overseeding did not improve the turfgrass stand density in the Terra Sorb and Soil Moist greens. The bentgrass was observed to emerge, but the seedlings wilted and died after attaining a height of approximately one-half inch.

The average density rankings of the greens showed that only Super Sorb F maintained increased stand density throughout the study (Table 4). There was a significant drop off in stand density with the polymers Terra Sorb and Soil Moist. This observation agrees with the research of McGuire, Carrow, and Troll (1978) which showed that some polyacrylamides are detrimental to turfgrass growth.

To observe what effects these polymers had on turfgrass root development, cores were taken the full depth of the sand-peat mix at the end of the study and the soil washed away to expose the roots. There were significant differences among the root systems. (Figure 1 and Table 3)

TABLE 3.
EFFECTS OF POLYMERS ON RELATIVE ROOT WEIGHT AND DEPTH OF ROOTING.

Polymer	Rel. Root Weight*	Rooting Depth
		inches
Super Sorb F	1	14.0
Terra Sorb	6	19.5
StaWet	2	22.0
Soil Moist	5	14.5
Super Slurper	3	23.0
None	4	16.0

*Rankings: 1 = greatest weight, 6 = least.

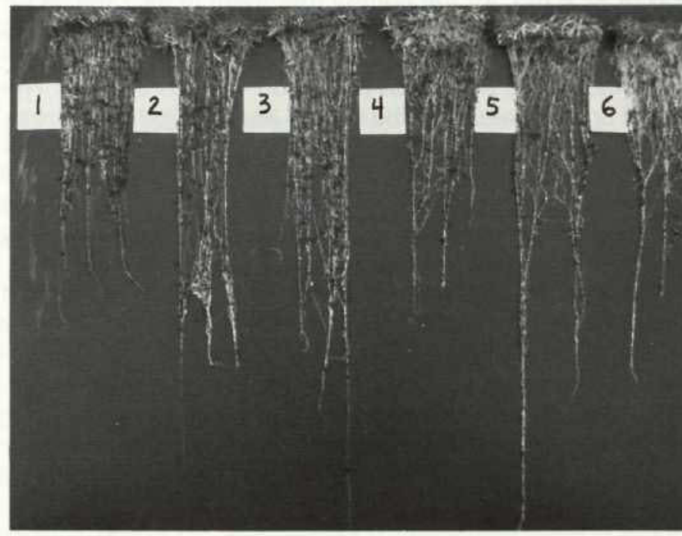

Fig. 1. Effects of the polymers on bentgrass root development. The treatments (L to R) are Super Sorb F, Terra Sorb HB, Sta Wet, Soil Moist, Super Slurper and the no-polymer control.

Greatest root growth occurred in the Super Sorb F treatment while depth of rooting was greatest in the StaWet and Super Slurper treatments. Compared to the control, Super Sorb F, StaWet and Super Slurper increased root weight and StaWet and Super Slurper enhanced rooting depth. Thus, from the standpoint of root development, the hydrolyzed starch polymers were more effective than the polyacrilamide polymers.

TABLE 4.
EFFECTS OF POLYMERS ON FERTILIZER N UTILIZATION

Polymer	Avg. Tissue N	N Uptake
	%	mg
Super Sorb F	4.71	64.7
Terra Sorb	4.14	59.3
StaWet	4.64	59.9
Soil Moist	4.46	35.0
Super Slurper	4.84	59.1
None	4.23	32.4

One claim made by soil polymer manufacturers is that these polymers improve drainage. The infiltration rates of each green were measured. The values ranged from approximately 41 to 59 inches/hr. The control green infiltration rate was 47.2 in./hr. Hence, polymers did not appear to greatly alter water infiltration. However, it needs to be noted that during the infiltration measurement Terra Sorb floated to the surface of the green and the Soil Moist column was considerably slower to drain than the other treatments.

The effects of the polymers on fertilizer N use were examined by analyzing for nitrogen in clippings removed over a three week period that began two weeks after application of 1 lb. N/M as Nutralene. All the polymers but Terra Sorb seemed to enhance tissue concentrations of N (Table 4). Since tissue N concentrations are affected by turfgrass growth rates as well as the amount of N absorbed, nitrogen uptake by the bentgrass was calculated. Over the three-week period, nitrogen uptake values ranged from a low of 32.4 mg. for the control treatment to 64.7 mg. N for the Super Sorb F treatment (Table 3). The N uptake data suggest that, with the exception of Soil Moist, all of the polymers increased bentgrass utilization of the N applied. The low N uptake values for the control and the Soil Moist treatments were not due to low tissue N concentrations (Table 4), but to slow growth rates. These slow growth rates were attributed to a P-deficiency that developed in the Soil Moist and control treatments and was subsequently corrected by applying 0.38# P_2O_5/M as potassium phosphate.

Due to this P deficiency in the control treatment, it would be improper to suggest that several of the polymers directly influenced N uptake. Rather, these polymers somehow enhanced P uptake and, as a result, favored high N uptake.

**TABLE 5.
EFFECTS OF POLYMERS ON BENTGRASS QUALITY RANKINGS AFTER 6 DAYS WITHOUT IRRIGATION.**

Polymer	Quality Ranking
Super Sorb F	5
Terra Sorb	1
StaWet	2
Soil Moist	4
Super Slurper	3
None	6

*1 = best, 6 = worst.

To examine the effects of the polymers on moisture supply, the greens were left to dry out for six days and turfgrass conditions noted. Bentgrass in the control green grew very little and was almost completely brown after six days without irrigation. This is reflected in the turfgrass quality rankings shown in Table 5.

On March 31, all greens were topdressed with ¼-inch cutting height. A nitrogen deficiency immediately developed in the Super Slurper treatment. The deficiency persisted for five days, after which the grass slowly recovered its normal color. This sequence of events strongly suggests that topdressing of this green somehow led to denitrification loss of nitrogen.

Summary and Conclusions

Short-term effects of several water-absorbing polymers on bentgrass grown in simulated USGA-type greens were observed. No one polymer consistently improved grass germination, stand density, rooting and drought survival. Some actually exhibited detrimental effects.

Field research has yet to demonstrate the long-term effects of polymers on the quality of bentgrass putting greens at this time.

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