Water-Absorbing Polymers Show Promise In Turf

By Jeff Nus, Mike Boaz, and Dan Wofford, Jr.

Turfgrass managers are under increasing pressure today to use irrigation resources wisely. Reductions and restrictions of water use by many municipalities in the U.S. and other countries have made conservation and efficient use of water a necessary goal (Watson, 1985). The United States Golf Association (USGA) and the Golf Course Superintendents Association of America (GCSAA) have placed high priorities on developing drought resistant and/or low water-using turfgrasses and management strategies for the 1990s (Bengeyfield, 1988).

One strategy that possesses great promise for reducing the need for supplemental irrigation on turfgrass sites is the use of water-absorbing polymers to increase the amount of available moisture within the turfgrass rootzone.

One must consider several factors in determining appropriate strategies to reduce irrigation needs for turfgrass. The "water budget concept" (Carrow, 1985) is very useful in this regard. A water budget tracks available moisture much like a checking account reflects one's financial assets. It is based upon moisture inputs, reserve, and outputs.

Moisture inputs include irrigation, precipitation, and moisture provided by capillary rise from shallow or perched water tables. Proper irrigation scheduling involving multiple cycling and proper timing can go a long way to reaching the goal of efficient water use (Meyer and Camenga, 1985).

The output side of the water budget concept equation includes evaporation from the soil surface, transpiration by the turfgrass canopy, runoff due to saturated or compacted soil conditions, and leaching beyond the rootzone. The proper choice of turfgrass cultivar (Beard, 1985) in combination with proper irrigation and other cultural techniques (Shearman, 1985) can limit unnecessary levels of output from the water budget equation.

The amount of reserve moisture held in the turfgrass rootzone depends primarily on the soil texture, effective rooting depth of the turfgrass species, and the presence of any perched water table (e.g., USGA spec putting green) or drainage barrier (e.g., Purr-Wick or PAT systems).

Olathe Polymer Planter treating baseball outfield in Lancaster, CA. Photo courtesy: Dan Wofford, Jr.

Water-absorbing polymers can greatly increase the amount of moisture available in the turfgrass rootzone (Azzam, 1980). This can be especially important in non-irrigated sites, in very coarse-textured, doughty soils, or in sand-based rootzones. Depending upon the manufacturing process, water-absorbing polymers can absorb hundreds of times their weight in water (Bowman et al, 1990) and up to 95 percent or more that water can be released to growing plants (Azzam, 1980).

By increasing the amount of available moisture in the rootzone, the length of the irrigation interval (number of days between irrigations) can be lengthened. Since evaporative losses are greatest during and immediately after irrigation when the turfgrass canopy is wet (Pair et al., 1983), strategies to reduce irrigation frequencies by lengthening the irrigation interval may lead to significant improvements in irrigation efficiency and lower the need for supplemental irrigation.

There might be other potential benefits for turfgrass sites from the use of water-absorbing polymers that aren't quite so obvious. Turfgrass managers are constantly battling the detrimental effects of compaction on turf performance. This is especially true for sports turf managers whose responsibilities include the maintenance of practice fields which become extremely hard and unsafe for the athlete due to the extreme amount of use.

The commonly accepted approach is to use various cultivation techniques to reduce compaction (Carrow, 1990). However, there is mounting evidence that some cultivation methods are ineffective at reducing compaction, or due to limited depth of penetration, the compaction zone is simply moved to a lower depth. In cases where compaction pressures are extreme, improved cultivation strategies are needed to ensure the safety of the athlete and provide greater turf performance.

Water-absorbing polymers are amazingly absorbent and expand a great deal when hydrated. How could this expansion property be of benefit?

Hydrated polymers have been described as having the consistency of "triple-strength gelatin." You can squeeze hydrated granules between your fingers and they spring back after compression. Wouldn't the addition of water-absorbing polymers into turfgrass rootzones provide not only a dramatic increase in available water, but also a much needed "shock absorbing" property to these compaction-prone sites? If so, some degree of compaction resistance would be realized (Terry and Nelson, 1986).

There is a third possible benefit of water-absorbing polymers. This is aerification. Present injection techniques involve placing polymers as dry granules a few inches below the soil surface in established turf. As the dry granule absorbs water and expands, it occupies additional space. As water is drawn from those hydrated granules by roots in close proximity or growing right through the polymer, the hydrated granules shrink. Depending upon the strength of expansion, wouldn't the addition of water-absorbing polymers add an element of aerification from these shrink-swell cycles?

Hydrated polymer 4 1/2 inches below surface.

To test these potential benefits from water-absorbing polymers, a series of experiments were designed and implemented at Kansas State University over the past two years. Olathe Manufacturing graciously provided the funding for the project and Western Polyacrylamide, Inc. donated the cross-linked polyacrylamide to be used.

The first experiment was conducted on an active soccer field at the Anneberg Sports Complex in Manhattan, KS. It was designed to compare conventional hollow tine coring versus grooving alone and in combination with the addition of cross-linked polyacrylamide (AB3, Allied Colloids). The polymer was placed approximately three inches below the soil surface at the rate of 170 pounds per acre on one part of the field with an Olathe 831 Polymer Planter. A different portion of the field was grooved by the planter without injecting polymer.

The goal was to evaluate certain parameters, including turf quality and rooting, as well as the moisture content, penetrometer resistance, impact absorption, and bulk density of the rootzone. It was important to establish whether grooving alone, or in combination with injection of the polymer, result in better turf performance and a softer (hence safer) field for the soccer players when compared to conventional hollow tine coring.

Average monthly quality ratings of the soccer field were recorded. Conventional hollow tine coring did not improve the turf quality of the tall fescue soccer field compared to the control plots receiving no cultivation. In fact, during July and August, plots that were hollow tine cored exhibited

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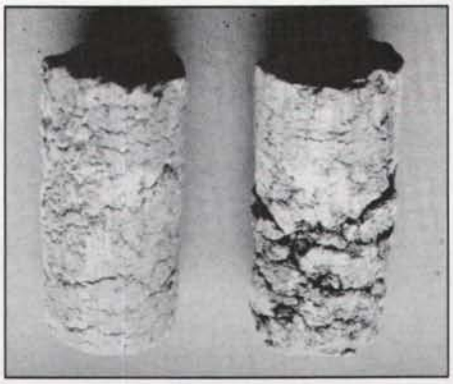
significantly poorer quality than controls.

Grooved plots exhibited superior quality than controls and additional quality enhancement was realized when the polymer was added. This was especially true during the months of August and September, when the irrigation system was shut down for repairs and little rainfall occurred.

Plots with polymer were showing much superior quality compared to the other treatments. This was due, at least in part, to the additional moisture held within the turfgrass rootzone. The average soil moisture was monitored to a depth of 15 cm (roughly six inches) by time domain reflectometry during a dry-down period from July 23 to August 10.

Grooved plots with and without the polymer showed superior moisture content to either hollow-tine cored or control plots. An evaluation of soil cores indicated that the addition of polymer resulted in an average increase in root mass of 30 percent.

Soil penetration resistance was measured at 5, 10, 15, and 20 cm depths with a recording penetrometer. Conventional hollow-tine coring had little effect on penetration resistance at a depth of 15 cm (about six inches). However, grooving significantly reduced penetrometer resistance. Adding cross-linked polyacrylamide reduced penetrometer resistance even further reflecting a less dense rootzone. Differences between the control, hollow-tine coring, grooving alone, and grooving with polymer were consistent as the soil was allowed to dry down.



Soil core on right from polymer treated plot exhibits cracking not found on core from control plot.

Hardness of the rootzone was also measured with a Clegg Impact Absorption meter. This device measures the deceleration of a known mass when it hits the soil surface after being dropped from a constant height. Plots were tested with the meter on June 12, 1990. Higher values indicate harder surfaces.

Again, conventional hollow-tine coring did little to soften the turfgrass rootzone compared to the control plots. Grooving significantly softened the rootzone compared to either the controls or hollow-tine coring. The addition of polymer further softened the rootzone compared to grooving alone.

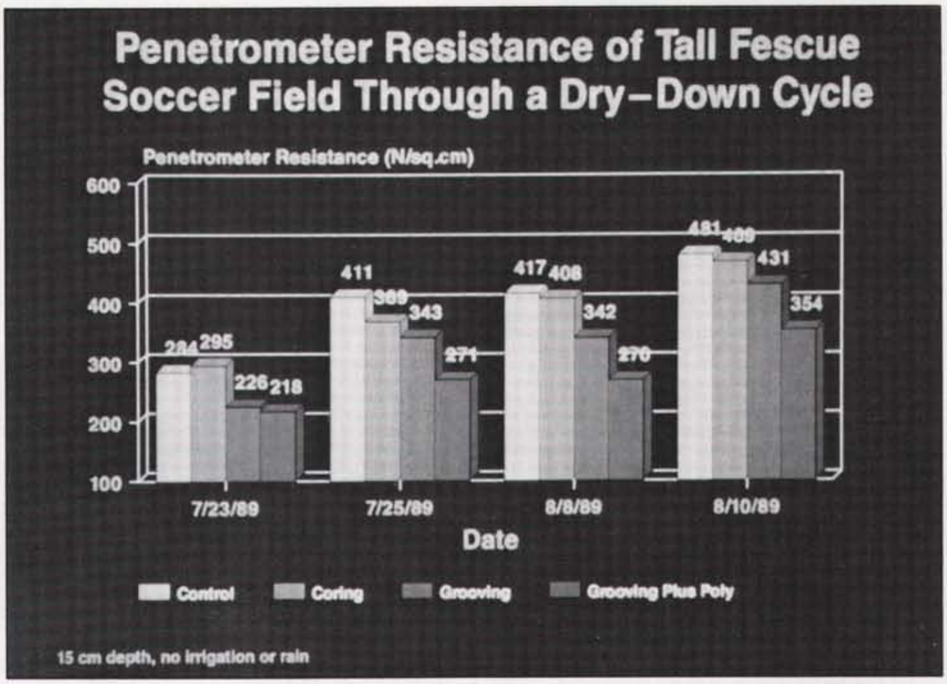
The data collected suggest that the addition of water-absorbing polymers to sports fields under constant, moderate to severe compaction pressure might represent a feasible method to reduce field hardness and related sports injury. Furthermore, it suggests that we might need to reevaluate the effectiveness of hollow-tine coring as a commonly accepted cultivation method to reduce compaction.

Additional evidence that the water-absorbing polymers were affecting soil strength became apparent when soil cores were removed. Nearly every core taken from polymer-added plots exhibited dramatic cracking and loosening, while control plot cores exhibited little cracking and loosening and a more dense condition. These observations support the theory that the expansion-contraction cycles of the polymer were having a substantial effect on loosening the turfgrass rootzone.

To determine how much cross-linked polyacrylamide is necessary to significantly affect irrigation intervals, several 15 x 15 foot, independently irrigated plots were injected with different amounts of the polymer using the Olathe 831 planter. Established plots of Mustang tall fescue were treated with 0, 20, 40, 80, 160, and 320 pounds per acre.

They received no rainfall from August 17 to September 17. Each plot was irrigated only when time domain reflectometry indicated a soil moisture content of 24 percent (vol:vol). The average number of days to reach this level of moisture depletion was recorded for each plot.

Little difference occurred until rates exceeded 80 pounds per acre. Best results were realized with 160 and 320 pounds per acre treatments. Based on these data, significant improvement of the irrigation interval begins at rates of 150 to 200 pounds per acre. Adjustments might be necessary depending on the type of polymer (e.g. starch, polyacrylates, or cross-linked polyacrylamides) and soil type (e.g., clay versus loam or sand).



Differences in field hardness levels were consistent as the soil became drier.

The results of these studies suggest that the use of water-absorbing polymers might present considerable potential benefit for turfgrass sites from the perspectives of both irrigation management and compaction resistance. Although these results are very encouraging, additional research needs to

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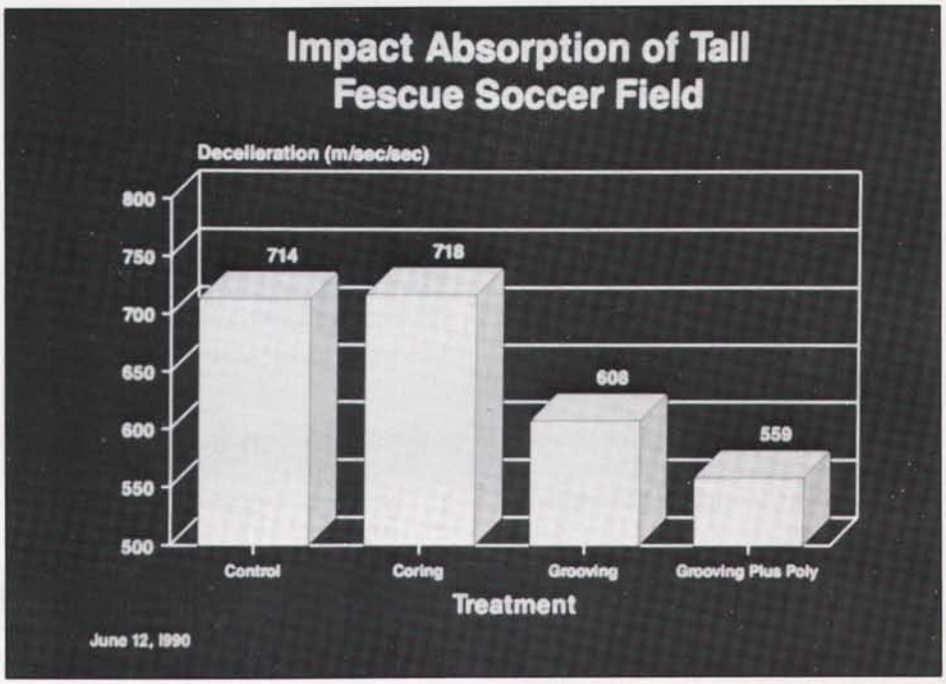
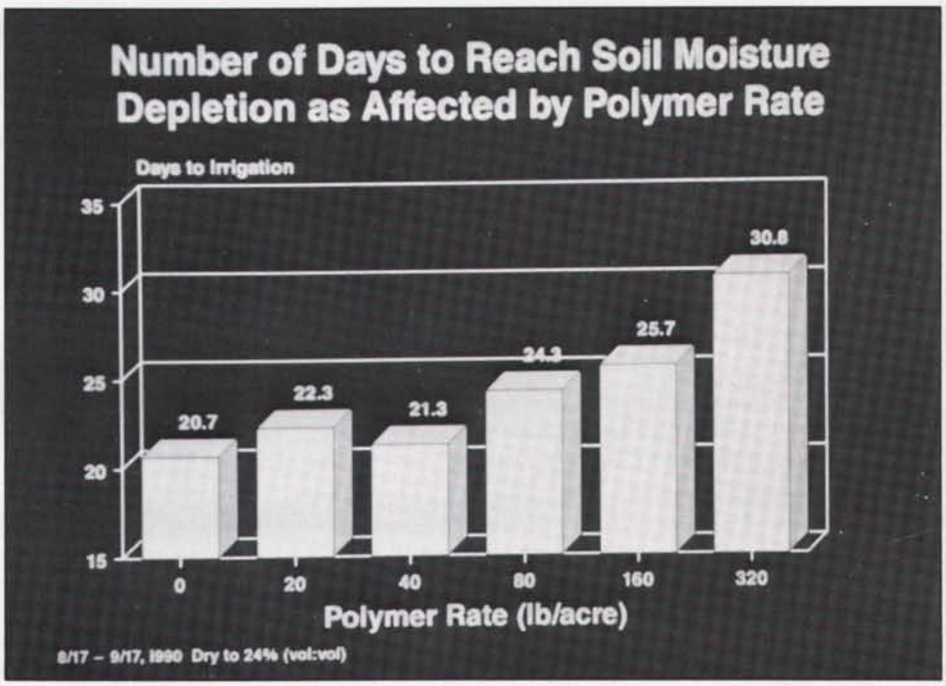
be completed before a thorough understanding of the benefits of these materials for turf is realized.

For instance, certain fertilizers, saline irrigation water, or saline soils can greatly reduce the absorbency of certain water-absorbing polymers (Bowman et al, 1990). Starch polymers are different from synthetic polymers in their rates, water-holding capacities, and longevity in the soil system. There is also evidence that too high rates of water-absorbing polymers can be detrimental, resulting in loss of turf density. There might also be benefits or drawbacks from the use of these polymers that we have yet to consider.

Kansas State University is conducting additional studies to investigate the effect



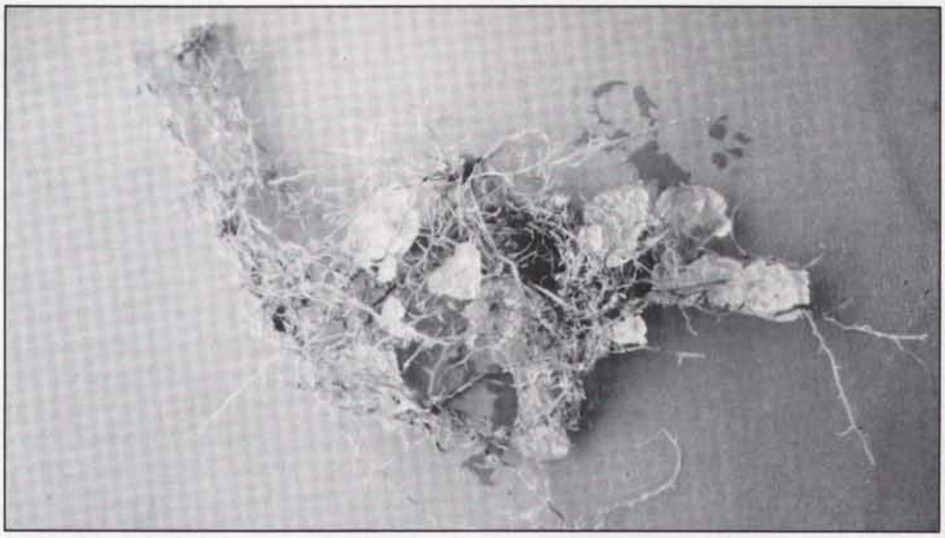
Grooving, with or without polymer, softened the heavily-used soccer field more than hollow-tine coring.



Irrigation intervals were lengthened significantly at polymer rates of 150 pounds per acre.

of both starch and cross-linked polyacrylamide polymers on water holding capacities, expansion strengths, oxygen diffusion rates, bulk densities, and impact absorption of both natural soil and sand-based rootzones. Research is also underway on how the behavior of these materials is affected by differences in initial bulk density, salinity, applied pressures, and rates. Finally, experiments with the polymers have been initiated on tall fescue, Kentucky bluegrass, perennial ryegrass, and creeping bentgrass.

Although much more needs to be learned, results to date are encouraging and suggest that water-absorbing polymers might play an important role in turfgrass management in the future.


Addition of polymer increased root mass by as much as 30 percent.

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