MOISTURE RELATIONS AND BENTGRASS ROOTING IN SIMULATED GOLF GREENS

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Turf and Grounds Management
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The Green Section of the USGA has meticulously set forth specifications for construction of golf greens. The primary purpose of specifications for the root zone mix is to provide maximum compaction resistance while ensuring high water infiltration rates and adequate moisture holding capacity and aeration.

For many reasons, golf course architects and superintendents deviate from the USGA golf green specifications. The purposes of this study were to characterize the moisture relations of simulated golf greens of various compositions and to note associated effects on bentgrass root development.

METHODS

The simulated golf greens were established in six-inch diameter PVC pipes previously drilled to allow for moisture measurement (Fig. 1). The greens materials listed in Table 1 were combined as shown in Table 2. In all but column 6, the green mixes were underlain by 1.5 inches of very coarse sand. All greens contained four inches of pea gravel overlying a perforated plate at the bottom of each column. All mixes were compacted to a uniform bulk density of 1.4g/cc and no subsidence was observed over the duration of the study.

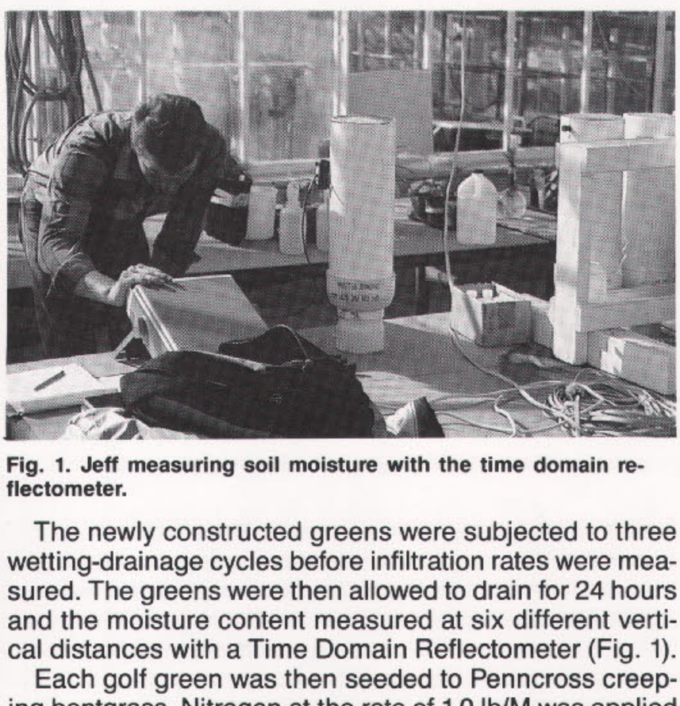


Fig. 1. Jeff measuring soil moisture with the time domain reflectometer.

The newly constructed greens were subjected to three wetting-drainage cycles before infiltration rates were measured. The greens were then allowed to drain for 24 hours and the moisture content measured at six different vertical distances with a Time Domain Reflectometer (Fig. 1).

Each golf green was then seeded to Penncross creeping bentgrass. Nitrogen at the rate of 1.0 lb/M was applied as 19-25-5 at the time of seeding. A second pound of N was applied three weeks later as 22-0-16. One month later the grass showed N stress and 0.5 lb. N was applied as a urea solution.

Once established, the bentgrass was clipped every other day at a ½-inch height. The greens received 0.2-inch water daily. On three separate occasions 0.5 inch "rain" was applied to each green, leachate collected for two hours and analyzed for N, P and K content. Phosphate concentrations were consistently below detection limits.

Infiltration rates of the greens were determined again 11 weeks after grass establishment. As had been done previously, the columns were allowed to drain for 24 hours and moisture measured at different soil depths. Irrigation was then suspended for two days, at which time the bentgrass was showing signs of moisture stress. The moisture contents of the greens were then measured for the third and final time.

After one week of daily watering, rectangular metal frames measuring 1.5 x 4 x 24 inches were driven into the columns a depth of 12 to 13 inches. These were extracted from the greens and the covers replaced by pin boards. The sand was then carefully washed away. The isolated plants with intact root systems were then photographed (Fig. 2).

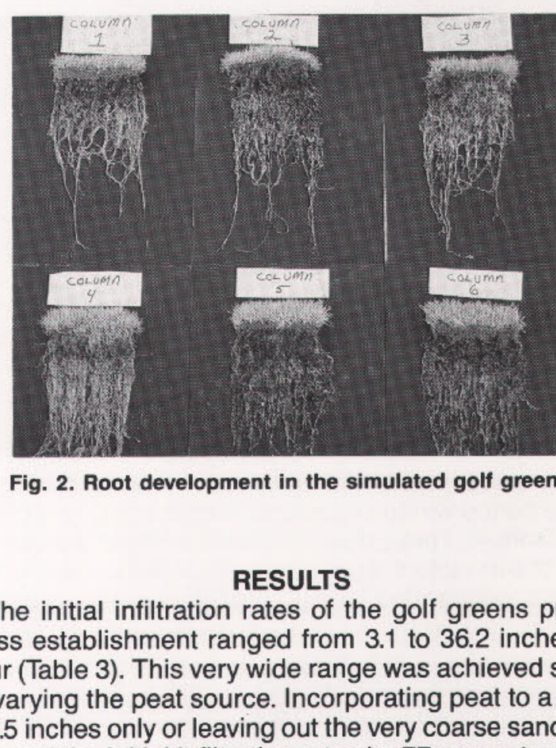


Fig. 2. Root development in the simulated golf greens.

RESULTS

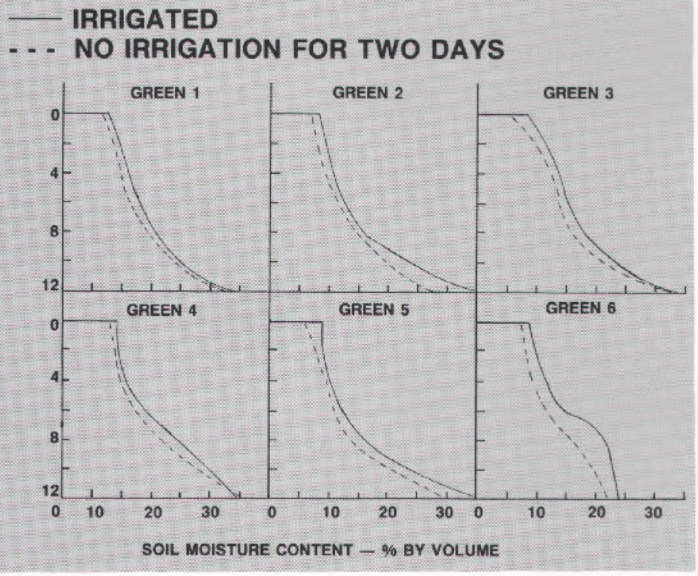
The initial infiltration rates of the golf greens prior to grass establishment ranged from 3.1 to 36.2 inches per hour (Table 3). This very wide range was achieved simply by varying the peat source. Incorporating peat to a depth of 5.5 inches only or leaving out the very coarse sand layer reduced the initial infiltration rates by 77 percent or more (greens 2 vs. 5 and 6). Shifting from the 80:20 mix (green 2) to the 80:10:10 mix reduced the infiltration rate by only 22 percent.

The anticipation was that as bentgrass roots filled in the larger pores, water infiltration rates would decrease. This did occur, but not in all the greens. Where it occurred (greens 1, 2, 4 and 5), the infiltration rates declined 42 to 75 percent. Infiltration rates on greens 3 and 6 actually increased by 47 to 63 percent after the bentgrass was established. Thus, in those greens whose infiltration rates were initially very low, grass root penetration somehow enhanced water infiltration.

The moisture profiles of the six greens are shown in Figure 3. At first glance, only green 6, the one without the very coarse sand layer, appears to have a distinctively different moisture profile. Placing the sand-peat mix directly over the pea gravel rather than over very coarse sand apparently produced a more pronounced perched water table. This is to be expected given the differences in pore sizes in the very coarse sand and pea gravel.

Differences in the golf green moisture profiles when fully wet or after a two-day dry-down period are difficult to detect visually (Fig. 3). Therefore, areas under the soil moisture curves were integrated graphically to reveal relative

Figure 3. Simulated Golf Green Moisture Profiles



differences in moisture retention and the percentages of water lost during two days of evapotranspiration. The results of these integrations reveal a general trend of increasing moisture retention with increasing degree of peat decomposition (greens 1, 2, 3 in Table 4). Incorporating the peat in just the top 5.5 inches of sand reduced total water retention by only four percent (greens 2 vs. 5). Leaving out the very coarse sand layer modified the shape of the moisture retention curve (Fig. 3) but did not notably alter the total amount of moisture retained (green 6 Table 4).

The amount of water lost via evapotranspiration over a two-day period varied considerably from one green to another (Table 4). These differences likely reflect the combination of two factors: (1) the amount of water retained in the grass rooting zone; and (2) the tension with which the water was held. Without quantitative measures of roots at different depths in the various golf greens, it cannot be deduced which of these two factors was more important. It was noted, however, that in green 5 where peat was incorporated to a depth of only 5.5 inches, bentgrass roots virtually did not penetrate the pure sand (Fig. 2).

Indications from the data in Table 4 are that the decomposed sphagnum (green 2) held water in a more readily available state than did the Manitoba sphagnum (green 1) or the Iowa peat (green 3). Substituting silt loam soil for some of the decomposed sphagnum reduced evapotranspiration loss of water (green 2 vs. 4) while incorporating this peat to only a 5.5-inch depth or leaving out the very coarse sand layer did not greatly alter water availability.

Nitrogen and potassium leaching losses from the greens varied two- to 20-fold (Table 5). Interpretation of these leaching losses are difficult because the different peats and the soil obviously contributed different amounts of N and K. However, because the same peat was used in greens 2, 5, and 6, some comparisons are possible. These comparisons show that shallow incorporation of peat increased N leaching but reduced K leaching. Leaving out the very coarse sand layer dramatically reduced leaching loss of N. But potassium loss did not change significantly, which leads to the suggestion that denitrification was responsible for the very low leaching loss from green 6.

Table 1. Putting Green Component Materials

Material					Characteristics
Sand: Waupaca Materials, Inc.; pH 7.3					
	Sieve Analysis				
	Size fraction				%
	V. coarse				0.7
	Coarse				17.6
	Medium				74.4
	Fine				6.9
	V. fine				0.4
Peats		Ash Content			
Source and type	pH	Total			Acid insoluble
		%			
Manitoba Sphagnum	3.6	8.40			6.58
Decomposed Sphagnum	5.8	16.0			11.9
Iowa	5.0	32.8			29.1
Soil Hockheim silt loam					
	Mechanical analysis				
	pH	0.M	Sand	Silt	Clay
			%		
	6.2	4.5	22	70	8

Table 2. Putting Green Constructions.

Green Number	Construction
1	80:20 Sand: Manitoba sphagnum over 1.5 inches very coarse sand
2	80:20 Sand: decomposed sphagnum over 1.5 inches v. coarse sand
3	80:20 Sand: Iowa peat over 1.5 inches v. coarse sand
4	80:10:10 Sand: decomposed sphagnum: soil over 1.5 inches v. coarse sand
5	80:20 Sand: decomposed sphagnum to a 5.5-inch depth, then 6.5 inches pure sand over 1.5 inches v. coarse sand
6	80:20 Sand: decomposed sphagnum without the v. coarse sand layer

Table 3. Putting Green Water Infiltration Rates		
Green Number	Infiltration rate	
	Initial	After 10 weeks
	inches/hr	
1	19.9	11.6
2	36.2	9.8
3	3.1	5.0
4	28.1	16.3
5	8.4	2.1
6	4.7	6.9

Table 4. Relative Amounts of Water Retained In The Top 12 Inches of Various Golf Greens And Water Use By Bentgrass in a 2-Day Period

Green Number	Relative amount of water retained	Loss over Two Days
1	87	6.7
2	94	15.6
3	100	9.6
4	99	9.7
5	90	15.5
6	96	17.2

Table 5. Nitrogen And Potassium Loss By Leaching

Green Number	Nitrogen	Potassium
	mg/column	
1	4.27	0.87
2	3.01	1.18
3	11.2	1.42
4	10.1	1.22
5	7.21	0.65
6	0.56	1.06

CONCLUSIONS

None of the simulated greens used in this study were replicated. While this means caution must be used in interpreting the results, some generalizations are possible. These are:

1. Choice of peat, depth of incorporation and whether or not a very coarse sand layer is used can markedly affect water infiltration rates in golf greens.
2. The declines in water infiltration rates of new greens over time is not entirely due to compaction. Grass root blockage of larger pores also appears to be involved.
3. The amount of water retained by golf greens is not greatly affected by peat source, depth of peat incorporation, use of an appropriate silt loam soil, or elimination of the very coarse sand layer.
4. The plant availability of water does, however, seem to vary substantially with the composition of the greens mix.
5. Although not quantified in this study, incorporation of peat into the top few inches of sand rather than throughout the 12-inch sand layer did appear to restrict bentgrass rooting depth.
6. Nitrogen and potassium leaching losses are influenced by depth of peat incorporation and, in the case of N, by elimination of the very coarse sand layer.

Editor's Note: Jeff Bahr will graduate at the end of this semester in mid-May. An outstanding student and recipient of a GCSAA, a NOR-AM, a WGCSA and a WTA scholarship during his undergraduate years, Jeff will be Pat Norton's Assistant Superintendent at Cedar Creek.

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PRACTICAL PREGERMINATION

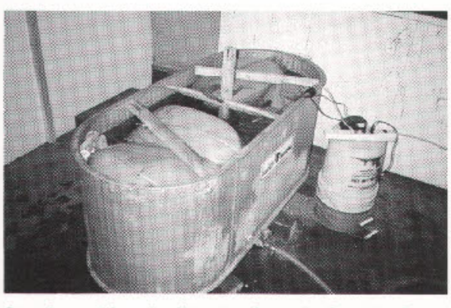
By Rod Johnson

This past winter's harsh weather and prolonged periods of ice cover have led to a great deal of concern for Wisconsin superintendents. With the arrival of spring it is now time to take inventory of our losses and to lay plans to insure the fastest possible recovery.

Experience continues to be an excellent teacher. The winter of 1987-1988 provided many similar circumstances at my locale with a resulting loss of seven plus acres of *Poa annua* fairway turf. The returfing of large areas is always a major headache, but doing it under less than optimum conditions is double jeopardy.

Winter damage, whether it's from extended ice cover, crown hydration, desication or other forces of nature, can cause a real dilemma. There are numerous frustrations and inherent problems. Recovery never seems fast enough for overly anxious golfers waiting to flex their golf muscles and to test their new-found "*Golf Digest* Swings."

Seeding of new grass seems logical, but cold spring temperatures usually limit success. Soils at a two-inch depth must warm to temperatures of at least 60° F to be capable of germinating bentgrass seed. It could be mid-June in many areas of Wisconsin before soil



Seed soaking in livestock watering tank.

temperatures reach this level. Waiting that long to seed would be unsatisfactory and I doubt new seedlings started in June would be able to survive the coming summer's stress. A June seeding would also probably be a wasted effort due to the competition from a fresh crop of *Poa annua* or possibly from common turfgrass weeds.

Faced with a large scale turf loss and willing to try anything short of sodding seven acres (the $52,000 price tag would have been tough to sell), I decided to try the pregermination of bentgrass seed. Like most of us, I had tried pregermination on a limited basis with a reasonable success level. The pregermination of 350 pounds of bentgrass seed presented a physical challenge as well as a mental stress. The cost of the limited availability of bentgrass seed leads to a great deal of anguish.

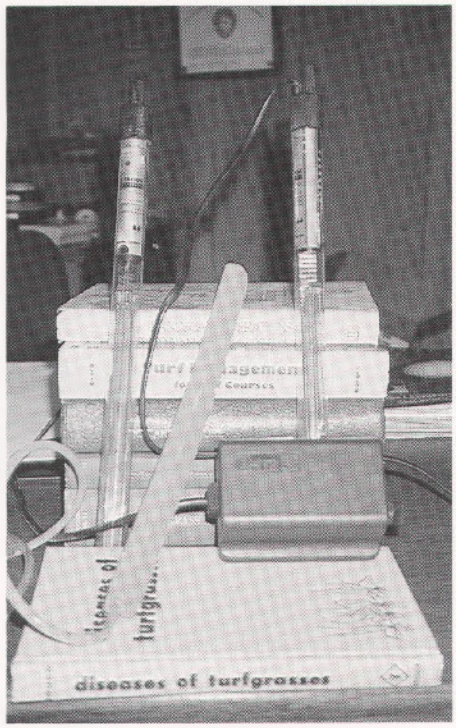
"The cost and limited availability of bentgrass seed leads to a great deal of anguish."

Having gathered information from numerous experts, a Cushman load of Penncross seed was readied for action. Penncross was the grass of choice due to its known aggressive growth characteristics with hopes of its future competitive abilities. Ryegrass, known for its fast establishment, was ruled out because of past failures and a questionable ability to survive future winters.

Mark Grundman, Field Representative for Northrup King, provided a great deal of the expertise for the project. His research and experience showed that to achieve maximum results several specific steps needed to be taken. Seed was to be fully submerged in water that was kept at a constant 75° F for a period of five days. Further, the water had to be changed every 12 hours and seed bags hung to allow complete water drainage and water change. His past experience also showed the best results from using water under continuous aeration.

These steps seemed simple enough on a small scale, but the space requirements of 350 pounds of bentgrass seed presented the physical challenge. After a great deal of thought and quite a bit of experimentation, we arrived at our equipment needs.

A small heated section of our shop basement was sectioned off to be used as our nursery area. A 110 gallon livestock watering tank proved to be just the right size vessel to allow for the submersion of the seed. A hose bib



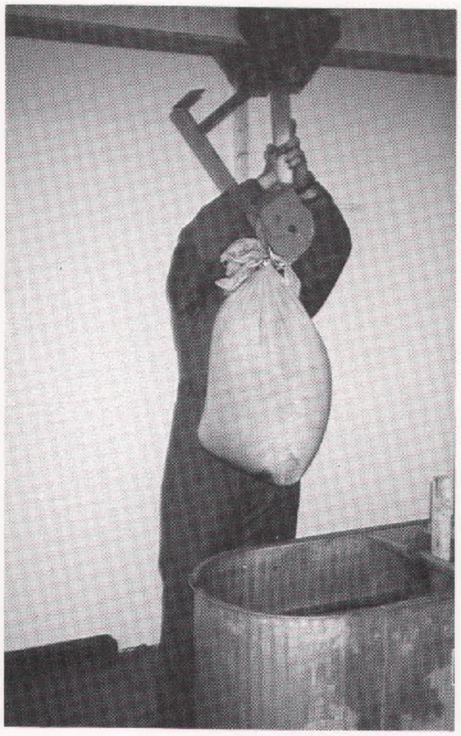
Aquarium heaters and aeration pump.

was added to the bottom of the tank to facilitate the previously mentioned water changes. The seed was hung for drain down on the twelve hour intervals with the much needed aid of a ceiling mounted winch.

Some relatively inexpensive equipment was purchased from a local pet store to meet the temperature and aeration requirements. Two 300 watt aquarium heaters were purchased. These heaters were submergeable and were capable of keeping the water at the desired 75° F. Water already warmed was added to the tank at each change as these heaters were capable of holding the constant temperatures but could not be used as water heaters. An aquarium pump and two 12-inch airstones were also purchased to facilitate aeration and water movement.

Seed was transferred from its original poly lined bags into canvas bags capable of allowing water to pass through but holding the tiny bentgrass seeds in. Seed was pre-weighed and separated into bags containing the proper amount for each fairway to be reseeded. This was done due to the fact that weighing wet seed for a proper seed rate would have been impossible.

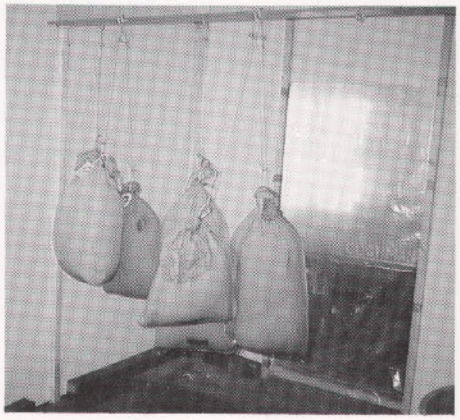
The soaking seed was monitored closely to be sure that water temperatures remained at the constant 75° F. Starting on the fourth day seed samples were removed from the bags at each water change. Samples were scrutinized with the aid of a Scotts 8 x 30 power macroscope for signs of radicle emergence. In seed germination, the radicle is always the first actively growing part to emerge. True to form, radicle emergence was first noted on the fifth day. This is the point



Bags of seed too heavy to lift being winched from tank.

when the pregerminated seed is ready to be planted and also, I suspect, the point when the potential for failure is greatest. Seed which has developed beyond this point is extremely fragile. Overdeveloped or overgerminated seed could be desicated during the planting operation. There is also the thought that overdeveloped seed could quickly succumb to nutrient deficiency because of a lack of phosphorous.

With these thoughts in mind, it is im-



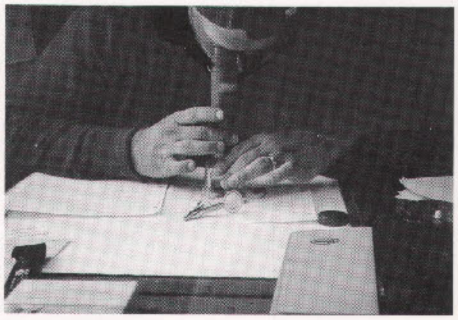
Seed bags hung to drain during water changes.

portant to anticipate the five day pregermination period and to have your seedbed prepared accordingly.

The methods we used to prepare our seedbed are not a mystery and have been employed by numerous superintendents. The affected fairways were thoroughly aerified and the cores were dragged for a topdressing. Grooves were then cut using a Rogers Aero-Blade three point hitch seeder. One variance from normal was that the seed was not loaded into this machine and cut into the grooves but was broadcast over the area later with a Vicon Spreader. This was done to ensure a more accurate calibration and to more evenly distribute the seed between the grooves and the aerifier holes.

The wet seed, ready for planting, was dumped on a cement floor for drainage and mixed with Milorganite for further drying. The Milorganite also acted as a seed carrier further aiding in the broadcasting of the correct seeding rate. Milorganite was added on a 4-to-1 basis, four pounds of Milorganite to one pound of seed, with the use of an electric cement mixer to ensure a homogeneous mix.

The broadcast seed mixture was dragged with a harrow mat and rolled to enhance seed to soil contact. A high quality starter fertilizer was then applied and the all important irrigation water was started. As with any seed-



Monitoring for Radicle Emergence.

ing, the seedbed must be kept moist and watering schedules adjusted accordingly.

Our results were outstanding. Bentgrass plants were identified in a two leaf stage 10 days after seeding, even with soil temperatures of much less than 60° F. Fairways which had been seeded on April 26th healed quickly and were opened for regular membership play one month later. A reasonably mature stand of turf allowed not only good playing conditions but unrestricted golf car movement on Memorial Day weekend.

The efforts of pregerminating on a large scale were well worth the results and would be worthy of your consideration should you be forced with recovering from water damage.

Letters

Roger Bell, President
WGCSA
Brookfield, WI 53005

Dear Roger,

Having reached the age of 65 and serving the Wausau Country Club as Golf Course Superintendent for 40 years, I decided on "early retirement" as of Jan. 1, 1989. Along with other retirement gifts, I received an Honorary Lifetime Membership to the WCC.

During my tenure, I supervised 30 different golf holes, due to re-designing and re-building. When the new front 9 was built in 1963, the Wadsworth Company installed their first fully automatic irrigation system on 9 holes in the Midwest at the WCC!

Also during this time, I worked with 6 different Golf Pros and 12 different Club Managers.

I began as a caddy along with my twin brother, Willie, who later became one of the Golf Pros for 17 years. A brother, Don, will remain as the Assistant Superintendent.

Sincerely,

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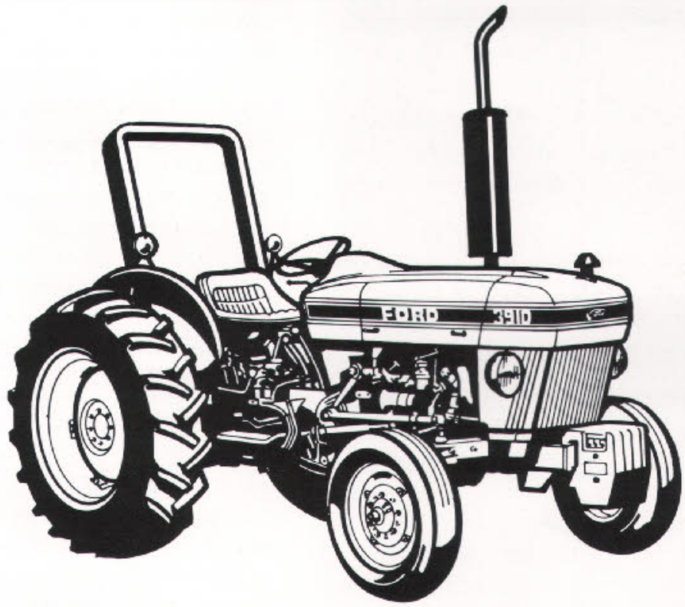

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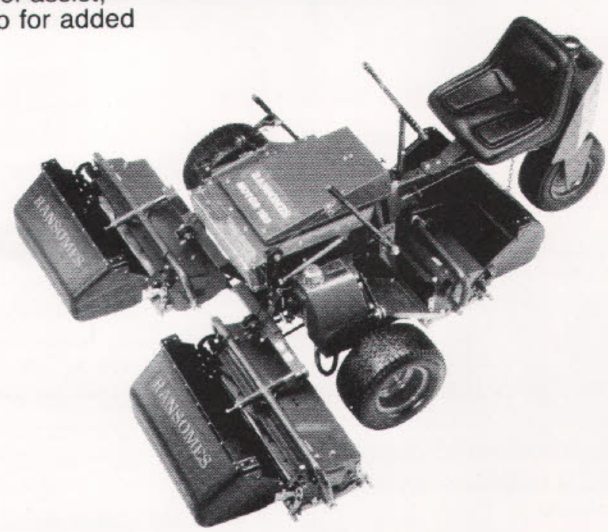

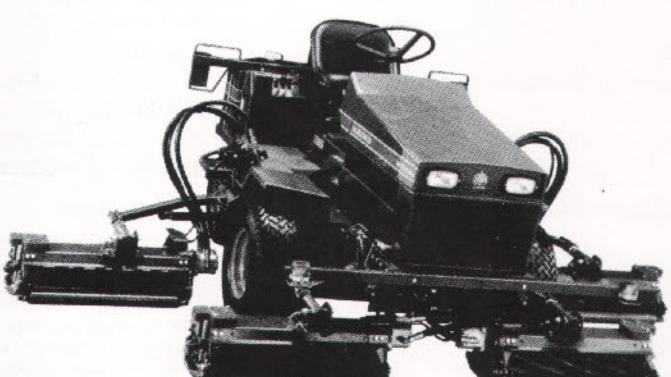

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WGCSA Honors Miller With Distinguished Service Award

"I do not deserve it, but I do accept it," remarked Monroe S. Miller after learning he was chosen to receive the WGCSA's coveted Distinguished Service Award. Those who attended the WGCSA spring business and education meeting witnessed a flushed and moved Monroe Miller as he accepted the DSA plaque from President Roger Bell. After a brief photo session, Monroe addressed the audience with some modest comments and thanked them for the award. The meeting was held March 14 at the Clarion Hotel in Fond du Lac. Monroe is the golf course superintendent at Blackhawk Country Club in Madison.

The Distinguished Service Award is not an annual occurrence. Rather a recipient is chosen at the conservative discretion of the WGCSA's officers and directors. One should ask "What kind of person receives the DSA?" It is someone who has given many years of dedicated, persistent service to the turfgrass industry. It is someone who demonstrates high standards of professionalism. It is someone who has strong leadership capabilities. Monroe's qualifications fit these criteria like the last piece of a jigsaw puzzle. He shares the DSA honor with the following past recipients:

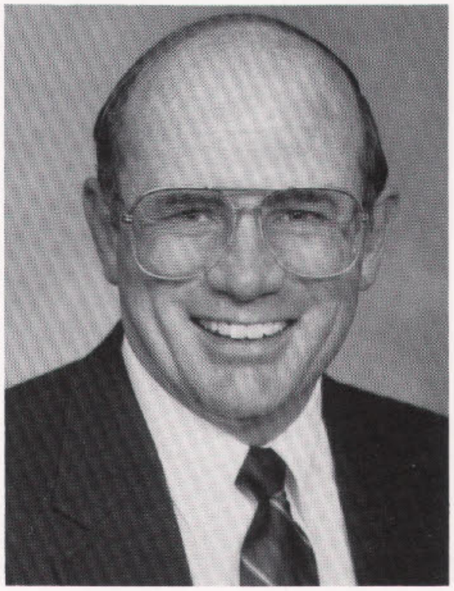
1. Les Verhaalen	4. Bob Welch
2. Bill Sell	5. Jim Belfield
3. Jim Love	6. Gayle Worf

Monroe's contributions blanket Wisconsin's turf industry. Some of his most noteable contributions are:

1. Monroe has given considerable leadership to the WGCSA. He has held the positions of secretary and vice-president. He served as president for the years 1984 and 1985. He has served on a wide variety of committees.

2. Monroe's role as editor of the *GRASS ROOTS* is well recognized. The March/April 1984 issue was his first. Thirty-two issues later, Monroe continues to provide WGCSA members with this valuable service. The quality of the *GRASS ROOTS* speaks for itself. The journal has won numerous national awards.

1984 — Best overall and Best original editorial content
1985 — Best overall, category C
1986 — Best overall, category C
1987 — Best overall, category C
1988 — Best overall, more than 16 pages



The *GRASS ROOTS* has rightfully earned its reputation as "The Best in the Nation." Notice that the awards are consecutive; further evidence of Monroe's persistent service.

3. Monroe had major responsibility for forming the Wisconsin Turfgrass Association in 1981. He has served in the capacity of secretary, director and newsletter editor. He shares the credit for the association's high level of success over the past nine years. The WTA provides approximately $30,000 annually to fund turfgrass research in Wisconsin.

4. The O.J. NOER CENTER for TURFGRASS RESEARCH is Monroe's most recent focus of energy. He has taken the idea from its conception to its present day fund raising campaign.

5. Monroe is a director of the Wisconsin Business Council's Forestry/Rights-Of-Way/Turf Coalition. Monroe's knowledge of pesticide issues is well respected. He has consistently worked hard to ensure that pesticide-use issues are discussed in equal light.

6. Blackhawk Country Club is well known by students as an excellent source for field training. Many internship papers can be traced back to work experience by students working for Monroe. The turf and grounds management program informally regards him as an "off campus advisor".

7. The WGCSA is not the only organization to recently honor Monroe. The College of Agriculture and Life Sciences presented him their Honorary Recognition Award. Monroe accepted the award April 7 at a banquet held in Madison. The award is part of the college's three day centennial celebration.

Some of Monroe's most significant contributions are subtle. He acts as a catalyst to stimulate others in our profession to react towards a particular cause or project. His work has increased the recognition of the turfgrass industry and profession significantly. He not only deserves recognition for his work, but for the way he does it. It is complete, articulate and professional. Some of Monroe's friends and colleagues have this to say about Monroe:

Leo Walsh — Dean of the College of Agriculture and Life Science — "I have never met anyone with more energy and drive for one's industry and profession. A most effective Agri-business representative."

Wayne Otto — Superintendent, Ozaukee Country Club — "Monroe's communitive skills, broad scope of knowledge, involvement in organizations and abundance of energy put him in a class all by himself."

Wayne Kussow — Professor of Soil Science and Turf and Grounds Management program advisor. University of Wisconsin-Madison — "Practical experience is the strength of our turf management program. No one has trained more turf students than Monroe. Without him, the program would be in serious trouble."

James Latham — USGA Agronomist-Great Lakes Region — "Monroe's earnest enthusiasm about any project he takes on guarantees its success — if not today, tomorrow."

All WGCSA members have benefited from Monroe's service. And for that service, it is our honor to present to him the **Distinguished Service Award.**

The author of this article is the Assistant Superintendent at a Milwaukee area country club. This humble young man has asked that his name be left anonymous in respect to its content. It is most impressive to note the skill and the accuracy with which it was written. Each carefully selected word shows the true respect that a young and relatively new member of WGCSA has developed not just for Monroe, but for our organization.

It should be noted that Monroe was not in favor of this article and that is understandable. It is very difficult for an editor to print anything about himself. The accounting of the honor which was given to him is most appropriate and served as a historical documentation. Again it is appropriate and much deserved.

— Rod Johnson

NOER CENTER NEWS

O.J. NOER CENTER for TURFGRASS RESEARCH Honor Roll

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Randy Witt

As we approach the halfway point in the fundraising period for the NOER CENTER, I find it incredible that there are only 17 golf courses represented in this list of donors: 17 out of over 400 golf courses in the state. More obvious than the generosity of the golf courses listed is the absence of nearly all of the state's largest, wealthiest and most prosperous clubs. Many individual WGCSA members — Wayne Otto and Randy Witt are the latest — have given. Manufacturing and distribution have done an excellent job although there are some notable absences here, too. So where are these golf clubs? We know they have the financial wherewithal to participate. And I'm willing to bet none would look me in the eye and declare, "We are against research and education."

Where are they? I hope we find them in the last half of the pledging program. There's no reason we shouldn't.

Kettle Moraine, Nakoma Lead Latest Golf Course Donations To The NOER CENTER

Dewey Laak, owner of the Kettle Moraine Golf Club in Dousman, and Randy Smith, golf course superintendent at the Nakoma Golf Club in Madison, are among the latest WGCSA members to pledge to the research center project for the University of Wisconsin. Each club pledged at the Medalist level.

Both men have long been active in the WGCSA. Laak is currently a member of the Board of Directors of the Wisconsin Turfgrass Association.

Jacobsen Donates to NOER CENTER

The Jacobsen Division of Textron, Inc. from Racine gave evidence of their commitment to turfgrass research in Wisconsin when they contributed $1000 to the O.J. NOER CENTER for TURFGRASS RESEARCH in December.

In a letter to the University of Wisconsin Foundation, Jacobsen Vice-President Ned Brinkman said, "We wish you continued success in your drive toward improving turfgrass research in Wisconsin."

Jacobsen has been manufacturing turfgrass maintenance equipment in Racine since. Thanks to Ned and all of our friends in that company.

Is It Disease Or Nutrition?

By Ray Knapp

Many times a problem is diagnosed as disease and it is really nutritional. We frequently conclude that off-colored turf is disease. Last season I saw two types of examples where disease appeared to be the problem, when it was really nutritional.

I was at West Bend Country Club in early May, 1988. Bruce Worzella had several greens that were declining. Over a five to six day period a few small areas of yellowish turf increased in size and the number of greens affected were increasing. Looking at the areas from a distance, there appeared to be an orange colored cast. All the symptoms appeared to indicate Toronto C-15 decline.

Bruce had made an application of a dry granular fertilizer and two applications of wetting agents. He was on a good preventive disease program and had put on his first application of fungicide.

Dr. Worf was out of town, so Bruce sent several cup-size green samples to Dr. Roberts from Michigan. The diagnosis Dr. Roberts sent back was unexpected. He concluded there was an extremely high pH at the surface of the green. This was tying up the availability of nitrogen and causing the decline. He recommended spraying on two applications of one-eighth pound of nitrogen per 1000 square feet. The second application should be a week after the first. The source of water soluble fertilizer didn't appear to be important.

Roberts reported to Bruce that this had been happening on courses in Michigan and Illinois. The dry spring had precipitated the problem.

Bruce followed Dr. Roberts' recommendation. A week after his second application, the greens were nearly completely recovered.

I saw this same thing twice within the next six weeks at Tom Kramer's course — Silver Spring Country Club, and at Gene Garvis' course — Peninsula State Park. This was the second season Gene had this problem. They both got the same good results using water soluble fertilizer.

The three courses had two things in common that may help one diagnose the high pH surface problem. Theoretically, they had plenty of plant nutrition. However, it was tied up. Secondly, this occurred during a prolonged dry period. You wouldn't expect to see this during a period of normal rainfall.

I'm going to go out on a limb and say that many times on sandy greens where a problem was previously diagnoses as Pythium, the real cause was the high pH nitrogen tie-up syndrome. I think that this is true in some cases when results from pathological labs confirmed the presence of Pythium. I've always doubted some of the reports of Pythium on high sand greens.

The second nutritional disease problem occurred at Todd Rinks' course — Plum Lake Golf Course in Sayner. Todd had on and off problems for several years. He had sent several samples over that period to Dr. Gayle Worf. Most of the time, Dr. Worf wouldn't find any causal organisms. However, he did find *Fusarium* on one sample. Todd had used nearly every fungicide but none of them were really effective.

Todd's high sand green had purple-reddish spots over the entire surface. Some spots were small while others were the size of a soda can or a softball. Seeing this problem last fall, I recognized it as phosphorous deficiency.

Looking at Todd's soil test results, no one would have concluded this to be a possible problem. The greens had over 400 pounds per acre of phosphorous. For this laboratory test results of 200 pounds per acre would have been considered adequate. One thing Bill Kazda (former superintendent and manager for 35 years at Plum Lake) pointed out was that lead arsenate had been used in the past. It was possible that the arsenate was what was showing up as phosphorous in the soil test results.

Once the problem was diagnosed, many of the pieces of the puzzle fell into place for Todd.

In spring or fall he would send a purple-reddish sample to Dr. Worf. By the time it got to him, the soil would have warmed up, more phosphorous was then available and the symptom would disappear.

Todd also reported that because of the apparently high phosphorous levels, he had been using very little phosphorous for a nine year period.

For a field diagnosis of phosphorous deficient turf, you will always see the reddish or purplish areas. If you look at the individual grass plant, you will see the upper surface of the leaf has the typical deficient color while the lower surface will be a typically normal green.

In spring or fall when the symptoms appear one can bring a cup setter sized sample into room temperature. In 24 hours the deficiency symptoms will have disappeared because the higher soil temperatures will make phosphorous more mobile or available.

A quick way to eliminate these deficiencies is to apply .1 pound per 1000 square foot of phosphorous (P205) using monoammonium phosphorous (12-61-0). Any other form can be used. Some of the dry granulars will take a little longer because they need to get into the soil solution to become available to the plant.

In both these examples the superintendents were following sound fertility practices. Occasionally we will be involved in these unusual circumstances. Many times by pointing out these isolated instances, we find the problem is more widespread.

1988 Gypsy Moth Trapping Results

By Julie Nara
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Last year was another year in which Bob Edmonds and Bill Isakson in Milwaukee and Harold Line and I in Madison enjoyed the help of many gypsy moth cooperators throughout the state. We thank you for this invaluable help, and also for the time many of you took to report back to us.

Last year was an extremely interesting year for gypsy moth trapping. The good news is that the 1987 gypsy moth finds in Porterfield Township (Marinette Co.) apparently were blow-ins from an infestation just across the Menominee River in Menominee County, Michigan. The bad news is that we caught 599 moths in the state last year, more than in any other year except 1978.

Approximately 9,830 delta traps were set in 67 Wisconsin counties for detection and delimitation in 1988. This number includes traps set by the U.S. Department of Agriculture, the Wisconsin Department of Agriculture, Trade and Consumer Protection, the Wisconsin Department of Natural Resources, municipal and county Forestry Departments, and private cooperators. Also included were traps placed by the U.S. Forest Service in Chequamegon and Nicolet National Forests.

Systematic detection trapping was done in the northeastern part of the state and most of the male moths were caught in that area, especially in Kewaunee and Door Counties, where 225 and 219 moths were captured. The heaviest concentration of gypsy moth finds were near the Lake Michigan shoreline, and became lighter to the north and west.

Delimitation and mass trapping of the 1987 gypsy moth finds by the USDA in Porterfield Township led to the discovery of an infestation across the Menominee River in the Upper Peninsula of Michigan. There were 12 moths trapped in 11 traps on the Wisconsin side in Porterfield Township, but an egg mass survey proved negative.

Egg mass surveys were also done in Sister Bay (Door County), in Pierce Township (Kewaunee County), and in Chenequa (Waukesha County). Four egg masses were found in Pierce Township, none in the other two locations. Mass trapping and extensive delimitation trapping are being planned for 1989.

Thanks to all members of the Wisconsin Golf Course Superintendents Association who cooperated in our gypsy moth trapping program in Wisconsin. We are hoping for your help again this year.