TURFGRASS SOIL MANAGEMENT RESEARCH REPORT - 1994

P. E. Rieke, T. A. Nikolai, D. Roth, C. E. Kome, and D. Karcher
Crop and Soil Sciences
Michigan State University
East Lansing, MI

The research reported herein was conducted at the Hancock Turfgrass Research Center. The Michigan Turfgrass Foundation provided funds for half the salary for Thom Nikolai who carried out the field research conducted in this report. This support is gratefully acknowledged.

SOIL TEST CORRELATION STUDIES

Most new putting green turfs are established on high sand content soils, normally a mix of sand and peat. These soils have very low cation exchange capacities, usually 4 me./100 gm or less and very low surface area. The result is these soils hold very low levels of nutrients making it difficult to raise soil tests in spite of fairly high levels of nutrient applications.

Generally, golf course superintendents understand that potassium will leach readily from these sands. However, phosphorus levels in new greens are normally very low as well. There have been several reports of phosphorus deficiencies on new greens. Unfortunately, phosphorus deficiency could be misdiagnosed as a disease which could lead to application of un-needed fungicide. A deficiency of phosphorus results in slow growth with a dark green to purplish green color. The pattern of discoloration often takes on the appearance of a disease. If severe deficiency occurs the grass will have a tan color in the spring as turf comes out of dormancy. By late summer the dark green/purplish coloration may disappear until next spring.

The best approach with sand greens is to utilize soil tests for phosphorus. Most phosphorus soil tests on sand greens will be fairly low, particularly on young greens. Because the soil tests are low and sands do hold much phosphorus it is best to apply phosphorus regularly during the season. This is usually most easily done by using a complete fertilizer which contains some phosphorus. While we want to be sensitive to concerns about leaching of phosphorus in ground or surface waters, it is important to be sure the turf has enough phosphorus to establish quickly, provide a firm, sturdy sod and tolerate the stress conditions which will occur. It is not necessary to use very low rates of phosphorus to reduce the rate at which annual bluegrass encroaches a creeping bentgrass green. Phosphorus level has no impact on how fast annual bluegrass moves into the green.

When the research plot area was expanded in 1992 we established new putting green plot areas on a mixture of 85% sand, 15% peat built to U.S.G.A specifications. Soil phosphorus tests averaged about 4 lbs. per acre, a very low level. Clear phosphorus deficiency symptoms were evident.

A study was initiated to evaluate the effect of phosphorus fertilization on soil tests and turf quality of a newly established Penncross creeping bentgrass putting green. Treatments listed in Table 1 were applied in 2 applications annually. Treatment 1 receives no P; treatment 2 receives 1 lb. P_2O_5 per 1000 sq. ft. annually; treatment 3 receives 2 lbs. annually; treatment 4 receives 4 lbs. annually; treatment 5 received 4 lbs. P_2O_5 in 1993 only; treatment 6 is treated at the rate recommended by the Bray P_1 soil test; and treatment 7 is treated at the rate recommended by the Olsen soil test. Plot size is 4 ft. by 12 ft. with 3 replications. The green is mowed at 3/16 inch.

Quality rating data are given in Table 1. As the turf comes out of the winter the check plot is essentially yellow in color. There are deficiency symptoms on plots receiving lower rates of P as evidenced by the low quality rating data in May. As the growing season progresses the turf gradually recovers in plots with marginal phosphorus levels so that symptoms are evident only on the check plot and for the lowest rate of P treatment (August 5 rating date). Then as temperatures cool the turf begins to show deficiency symptoms again. This pattern occurred in both 1993 and 1994.

Phosphorus soil tests (Table 1) indicate that the available P levels are all very low except for treatment 4 which tested at 32 lbs. P per acre after having received 8 lbs. P_2O_5 per 1000 sq. ft. over the 2 year period. Treatment 5, which was treated only in 1993 has a P level about equal to treatment 3 which has received the same P level as treatment 5 after 2 years. These data point out the importance of applying P regularly throughout the year on new sand greens.

The potassium fertilization studies have continued on creeping bentgrass, Kentucky bluegrass and annual bluegrass. Rates of application of K_2O are none (check), 4, 8, and 12 lbs. per 1000 sq. ft. annually which are split into 2 lb. increments spread over the growing season. These studies were initiated in 1990. Plot size is 5 ft. by 7 ft. with 4 replications. Soil samples are collected in early November each year and analyzed for available K levels.

Data for the potassium soil tests on the loamy sand putting green for 1990 through 1994 are given in Tables 2 and 3 for the 0-3 and 3-6 inch depths, respectively. Tests for the check plots have remained consistently low over the years. These K levels are very low and should approach deficiency levels although there has been no evidence of wilting or loss of turf density through the years. It is interesting that the tests for treated plots have fluctuated somewhat from year to year with tests in both the 0-3 and 3-6 inch depths being slightly lower in 1994 than in earlier years. It is assumed there was greater leaching of K as a result of higher than normal rainfall during the growing season in 1994. In spite of the highest rates of application at 60 lbs. K_2O total for the 5 years there is a maximum the soil can hold in this loamy sand green. The excess K is leached from the surface into the 3-6 inch depth and beyond.

Soil K tests for 1990-1993 in the Kentucky bluegrass potassium fertilization study are given in Tables 4 and 5, respectively for the 0-3 and 3-6 inch depths. Note that much higher K levels are found in this loam soil which has a much higher cation exchange capacity. Still, there appears to be a maximum amount of K which the soil will hold with the balance leaching downward in the soil. Similar soil tests were found for the annual bluegrass plots growing on loam soil.

While these soil test correlation studies point out there is a maximum amount of nutrient which can be held in the soil it is important to follow reasonable fertilization programs. Do not use the high rates used in these studies. For sandy loams, loams and other soils with more clay, soil test recommendations should be provide adequate K for the turf. For sands and loamy sands, soil tests are not particularly helpful in predicting needs for K. For these soils we suggest using a ratio between N and K_2O as a basis for determining needs for potassium. If low annual N rates are applied (3 lbs. or less) use a ratio of 1N:1.5K_2O. That is, if there are 2 lbs. N applied for the year, apply 3 lbs. K_2O annually. For 4-8 lbs. N annually, follow a 1N:1K_2O. If more than 8 lbs. N are applied annually, use a ratio of 1N:0.75K_2O.

CULTIVATION STUDIES

A study initiated in 1989 to evaluate the effect of timing of cultivation of an annual bluegrass fairway turf was continued in 1994. At the initiation of the study the grass was predominantly annual bluegrass. The cultivation treatments are given in Table 6. In past years there has been little difference in the quality of turf observed as affected by treatment. In 1994 some differences began to appear. On May 24 the amount of annual bluegrass in the plots was evaluated. Plots which had been aerified just after seedhead production in about mid-June or in late Fall had the highest amount of annual bluegrass. Those plots with the lowest amount of annual bluegrass were the untreated check and plots aerified in the early spring. The reader is cautioned however, that it is not possible to be sure about whether the greater annual bluegrass populations were a result of treatment or random encroachment of bentgrass into the plot area.

In September, several of the plots were exhibiting wilting symptoms. Plots with the most wilting were those which were the untreated check and in mid-September. Normally, the September treatment would have been made by the date of these ratings, but with the wilting symptoms appearing this cultivation treatment was delayed until late September. Treatments with the least wilting were those aerified during high stress in mid-July and after seedhead production in about mid-June. Based on these data it appears that the plots which have been aerified more recently exhibit the least wilting. Whether this hold true in the future will be determined by additional dry down periods in 1995. Even if this response is consistent cultivation during the prime golfing season would be considered unacceptable by many golfers because of surface disruption by core cultivation.

TALL FESCUE FAIRWAY COMPACTION STUDY

In past years we have reported on the study to evaluate the effect of compaction on a tall fescue turf mowed at 3/4 inch and maintained under fairway conditions. Treatments include low traffic (3 passes per week with a vibrating roller filled with water); heavy traffic (6 passes per week); and an uncompacted check. At the initiation of the study in 1992 there was a small population of annual bluegrass in the plots. Our hypothesis was that with compaction there would be an increase in the annual bluegrass population. Data from Fall, 1993 showed a trend for an increase in annual bluegrass, but the differences were not significant. Surface hardness as measured with Clegg meter were higher on the compacted plots as would be expected. Soil cores were sampled in late Fall, 1993 and taken into the laboratory to measure the effect of compaction on water holding capacity. Data in Table 7 points out that compaction consistently decreased the water holding capacity over the range of 20 cm moisture tension (high moisture content) to 1 bar (medium moisture content). These moisture tension levels are in the range of soil moisture which is most available to the turf that occurs in the larger soil pores. This result is not surprising because compaction causes the loss of the largest soil pores through which drainage and aeration take place. These plots will be subjected to moisture stress dry down periods in 1995 to determine if there is any difference in susceptibility to wilt.

WETTING AGENT EFFECTS ON SOIL WETTABILITY

A study of an experimental wetting agent from the AquaTrols Corporation was conducted in 1993 and repeated in 1994. Treatments were applied to a Penncross creeping bentgrass green growing on a loamy sand soil. Treatments shown in Table 7 were applied on July 13, August 15 and September 17, 1994. AquaGro-L is the present liquid formulation of wetting agent which has been used in the industry for many years. The ACA 864 is an experimental wetting agent. All treatments were watered in immediately after application. Plot size was 4 ft. by 10 ft. with 4 replications. Because of regular rainfall in 1994 there were few differences in turf quality observed among treatments. In September there was a 2 week period during which there was no rain, permitting visual differences among treatments. All treated plots had less localized dry spot apparent on Sept 7 and 14. Color and quality ratings gave similar results.

Soil core samples were collected about one month after each treatment to determine if there was any effect of wettability of the soil at different depths. This measurement entails drying the soil cores for 1 month, then placing a water droplet on the soil at selected depths. The time for the water droplet to disappear is a measure of how wettable the soil is. The longer the time for the drop to penetrate the soil, the more hydrophobic is the soil. Data in Table 8 indicate that the experimental wetting agent applied at the rates of 4 or 6 oz. per 1000 sq. ft. on July 13 resulted in a decreased time for a water droplet to disappear when placed on the soil surface. Below the surface there was no influence of treatment as all shallow depths (1-3 cm) had relatively hydrophobic conditions.

For the second application date in August (Table 9) the highest rate gave faster water penetration at the 1 and 3 cm depths while no other treatment showed any benefit at those depths. It is interesting to note that all treatments had greater wettability than the check at the 5 cm depth. No treatment had a significant effect on wettability of the surface layer, although there was a trend for reduced times with the higher rates of the experimental material. Interestingly, there was a trend for reduced times deeper in the profile. Apparently, within one month the effect of the wetting agent on the surface layer had dissipated.

For the third application the two highest rates of the experimental resulted in greater wettability at the 1 and 2 cm depths of soil (Table 10). The experimental wetting agent appears to be an effective material for improving wettability of soil and reducing localized dry spot incidence. On several dates after application dew ratings were taken. AquaGro is much more effective than ACA864 in reducing dew. The experimental had some dew reduction effect for about 4 days while the effect of AquaGro lasted 5 to 8 days.

GREENS ROLLING STUDY

A study to evaluate the effects of rolling and mowing height on ball roll and turf quality was initiated during the summer of 1993 and continued in the summer of 1994. Plot size was 15 ft. by 5 ft. 4 in. with 4 replications. The treatments shown in Table 11 included rolling with an Olathe roller 3 times per week; a Jacobsen roller at 3 or 5 times a week; an unrolled check plot; and a treatment which received double mowing. All these treatments were mowed 6 times a week at 5/32 inch. One additional plot was mowed at 3/16 inch and rolled with the Jacobsen roller 3 times per week.

On three dates ball roll was measured the same day as treatments were applied utilizing the Stimpmeter. Rolling 3 times per week with the Olathe roller gave the highest ball roll numbers on the 3 dates analyzed as shown in Table 11. Over a period of months double mowing with no rolling was nearly equal to the Olathe treatment. Rolling 5 times per week with the Jacobsen roller outperformed 3 times per week on only 1 of the 3 dates analyzed. When rolled with the Jacobsen roller and mowed at 5/32 inch the Stimpmeter reading was better than when rolled and mowed at 3/16 on only one date (Aug. 1).

The seasonal average for all dates evaluated for these treatments was 9 ft., 10.5 in. for the Olathe, rolled 3 times per week; 9 ft., 7 in. for the Jacobsen, rolled 5 times; 9 ft., 4 in. for the Jacobsen, rolled 3 times; 8 ft., 9 in. for the check; and 8 ft., 7 in. for the treatment rolled with the Jacobsen 3 times and mowed at 3/16 in. To date these data substantiate observations on the effects of rolling from research in North Carolina and conducted by Beard and golf course superintendents in northern Michigan. The benefits of rolling and double mowing are obvious in increasing ball roll. Double mowing had rather inconsistent responses, giving increasing numbers as the season progressed. The increase in ball roll may have resulted from a decrease in turf density with continued double mowing. Double mowing should not be considered as a regular practice. This study will continue in 1995.

MULCHING TREE LEAVES INTO TURF

A separate report on this study was presented at the turf conference last year and the study will be continued through the 1995 growing season. The fifth annual treatment of tree leaves was applied in October, 1994. As in the past there has been no detrimental effect on the turf of mulching the leaves. In the studies we have conducted the leaves decompose within a few weeks with no apparent leaf material by the next spring. A report from Virginia Tech indicated there was some detrimental effect of the tree leaves on turf when very high rates of leaves were mulched. It is important to be sure the grass leaves are not buried by the leaf material so they are exposed to sunlight so photosynthesis can take place during the fall.

This study received wide spread exposure in the Fall of 1994. With the ban on yard wastes being sent to land fills many are looking for other alternatives for disposal of leaves. Presently many golf course and parks superintendents are mulching the leaves into the turf with no problem. For good success, the leaves should be dry, the area should be mowed frequently, and the rotary mower blade should be sharp so the leaf particles are fine enough to fall into the thatch layer and give little shading effect on the grass.

HYDROJECT STUDIES

Evaluation of the Hydroject as a cultivation and injection tool continued in 1994. Chris Miller completed his M.S. degree and moved on to gain experience in golf course management. Doug Karcher, a graduate from Ohio State University is continuing this research.

As we continue to conduct research and visit with golf course superintendents, there are varying patterns of use which superintendents are following. The following comments are based on research, discussions with superintendents, and a survey conducted by the Toro Co. Typical use for those who own their own Hydroject are treating from 4 to 10 times per year with an average of about 6 treatments per year. This use is normally concentrated during the summer months when other cultivation would not be feasible due to intensity of play. About half of the courses are using the Hydroject on sandy greens and half on native soil greens although the latter were not described. As we have stated in the past, the best cultivation program for a given turf depends on the soil problems which need to be addressed. So, the appropriate frequency of use of the Hydroject depends on these same problems.

Some superintendents have utilized the Hydroject for frequent treatment of special problems such as localized dry spots or high compaction areas. Such areas may be treated every 1 to 2 weeks when needed. A high traffic area such as where there is concentrated traffic on or off greens or on tees. Some have even used it on smaller areas of fairways which are compacted or subject to localized dry spots.

The other area of use of the Hydroject is injection of nutrients, wetting agents or insecticides. We have demonstrated that phosphorus and potassium can be placed deeper in the soil with the Hydroject. Sometimes the levels of these nutrients deeper in the rootzone are very low because deeper roots extract the nutrients at that depth, while fertilizers are placed on the surface. This is especially true for finer-textured soils with higher cation exchange capacities. Even though there were very low levels of K deeper in the root zone we did not see any increase in the amount of roots growing in that zone when potash were injected with the Hydroject. There was even some tendency for lower root weights when high rates of phosphorus were injected deeper in the rootzone.

The Hydroject is very useful for treating localized dry spots. In some cases injecting water alone can correct a dry spot. If the condition is more severe, injection of a wetting agent has increased the wettability of the soil and reduced the severity of the dry soil condition.

Among the studies conducted by Doug Karcher was one to examine the effects of injecting nitrogen with the Hydroject on fairway and putting green turf. Treatments included three rates of urea, either injected or surface applied. Plots that received subsurface injections of urea had consistently quality and color ratings than plots receiving surface applications. Injected plots had consistently higher clipping yields and nitrogen content in plant tissues than surface applied plots. This difference in response could be a result of volatilization of ammonia from the surface applications of urea. This could have occurred in spite irrigating the plots shortly after application. Interestingly, plots which received surface applications were more susceptibility to wilting than those receiving injected treatments.

Another study was on how cultivation practices affect annual bluegrass encroachment on a creeping bentgrass putting green. There was no effect of cultivation on the amount of annual bluegrass after one year. Treating with the Hydroject increased ball roll 20 cm (8 inches) immediately after treatment.

Other studies include the effect of Hydroject and other cultivation on rooting of sod on compacted subsoil and another on was initiated in August, 1994, to examine the effect of Hydroject treatments on the rooting of Kentucky bluegrass sod. No treatment was effective in improving rooting in this first study.

In 1995 we will be looking for a putting green which has about a 2-inch layer of sand topdressing overlying a native loam or clay loam soil below. A practice putting green or a nursery would be possible sites. If a golf course superintendent has such a turf condition which we could treat, please contact Paul Rieke.

MANAGEMENT OF SOD ON SUBSOIL

One of the studies in which there is great interest is the management of Kentucky bluegrass sod growing on compacted subsoils. We had hoped to initiate treatments this year, but because of regular and heavy rainfall through much of the growing season we were unable to finish the final smoothing process before beginning the studies. This plot area is in a very low part of the field plots at the Hancock Center. Obviously the soil does not drain and water collects on one portion of this research block.

IRRIGATION MODELING

Charles Kome is finishing his Ph.D. degree utilizing the plot area originally developed by Mike Saffel. While this project is not currently being funded by MTF, the plot area was developed with funds provided by the Foundation. Charles is utilizing data from these plots to study irrigation programming with the use of several different irrigation modeling programs.

Table 1. Bentgrass Green Phosphorus Fertilization Study 1994 Quality Ratings							Pounds of Phosphorus per Acre 0-3" Depth	
Treatment	May 2	May 24	July 15	July 28	Aug. 5	Sept. 19	Fall 1993	Fall 1994
1	2.0 c	1.7 d	2.0 e	2.0 d	1.8 b	2.0 c	3.7 b	4.0 b
2	6.2 b	3.0 c	3.0 d	4.7 c	5.0 b	7.0 ab	4.0 b	3.3 b
3	7.5 ab	4.3 b	4.7 c	5.8 b	6.8 a	7.0 ab	5.0 b	8.3 b
4	7.8 a	7.0 a	5.7 b	6.8 a	6.5 a	6.7 b	12.3 a	32.3 a
5	7.2 ab	7.2 a	5.8 b	6.7 a	6.3 a	7.0 ab	14.7 a	9.3 b
6	6.7 ab	6.5 a	6.2 ab	7.3 a	6.5 a	7.0 ab	14.7 a	26.3 a
7	7.5 ab	6.7 a	6.7 a	6.7 a	7.0 a	7.3 a	11.7 a	29.3 a

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Treatments Applied On July 27 And September 19 in 1994.

Table 2. Penncross Creeping Bentgrass Potassium Study

Potassium soil tests, 0-3" Depth

Pounds of K_2O/M applied annually	Carrier	1990	1991	1992	1993	1994
Check	------	46 c	53 d	62	51 d	40 d
Soil Test Result	KCl	118 b	149 c	108	159 c	92 c
4	KCl	130 b	146 c	137	188 bc	116 c
8	KCl	112 b	204 b	212	218 abc	167 b
12	KCl	222 a	290 a	219	290 a	188 ab
12	K_2SO_4	222 a	272 a	235	272 ab	200 a

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 3. Penncross Creeping Bentgrass Potassium Study

Potassium soil tests, 3-6" Depth

Pounds of K_2O/M applied annually	Carrier	1990	1991	1992	1993	1994
Check	------	34 c	34 d	38	36 d	30 d
Soil Test Result	KCl	108 a	89 c	78	109 c	82 c
4	KCl	60 b	76 c	74	93 c	76 c
8	KCl	60 b	127 b	177	140 b	108 b
12	KCl	118 a	200 a	177	216 a	158 a
12	K_2SO_4	114 a	217 a	196	212 a	152 a

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 4. Kentucky Bluegrass Potassium Study

Potassium soil tests, 0-3" Depth

Pounds of K_2O/M applied annually	Carrier	1990	1991	1992	1993
Check	------	145 d	134 d	135	120 c
Soil Test Result	KCl	292 c	269 cd	208	202 c
4	Kcl	360 b	361 c	342	348 bc
8	KCl	282 c	526 b	506	581 abc
12	KCl	465 a	736 a	739	932 a
12	K_2SO_4	458 a	882 a	673	781 ab

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation tests.

Table 5. Kentucky Bluegrass Potassium Study
Potassium soil tests, 3-6" Depth

Pounds of K_2O/M applied annually	Carrier	1990	1991	1992	1993
Check	------	253	69 c	76	78 c
Soil Test Result	KCl	103	109 bc	145	153 bc
4	KCl	116	165 b	229	220 bc
8	KCl	94	177 b	340	455 ab
12	KCl	145	314 a	450	747 a
12	K_2SO_4	149	340 a	506	589 a

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation tests.

Table 6. Cultivation Timing Study 1994 Data
Initiated 1989

Treatments	% of Poa May 24th	% of Plot under Wilt Stress		
		September 19	September 21	September 23
Early Spring (Mid-April)	50.0 b	9.0 bcd	10.8 b	16.3 bc
After Seedheads (Mid- June)	80.0 a	7.8 cd	7.5 b	12.0 bc
High Stress (July or August)	65.0 ab	4.8 d	4.0 b	7.8 c
September	65.0 ab	16.3 ab	16.3 ab	22.5 ab
Late Fall	77.5 a	12.5 bc	5.5 b	14.5 bc
Check plot	57.5 b	22.5 a	27.5 a	30.8 a
probability	.0116	.0017	.0517	.0120

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Table 7. Tall Fescue Compaction Study
Initiated 1992

Treatment	10 cm tension table	20 cm tension table	40 cm tension table	.1 bar	.33 bar	1 bar
Low compaction	5.3 a	8.3 ab	11.3 b	33.7 ab	28.14 b	32.8 b
High compaction	3.9 a	6.9 b	9.8 b	30.6 b	25.15 b	30.1 b
Check	6.5 a	10. a	14.2 a	38.2 a	35.7 a	39.0 a

Means in columns followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.

Low compaction treatments were rolled three times per week
while the high compaction treatments were rolled six times per week.

Table 8. Effects of Wetting Agent Treatment on Water Droplet Infiltration at various depths, Time In Seconds
Wetting agents applied July 13, 1994
Cores taken August 12, 1994

Treatments	Surface	1 cm depth	2 cm depth	3 cm depth	4 cm depth	5 cm depth
Check	569 ab	509 a	433 a	374 a	160 a	103 a
AquaGro L @ 8oz./M^2	594 a	595 a	439 a	497 a	258 a	104 a
ACA 864 @ 6oz./M^2	180 d	358 a	382 a	302 a	145 a	58 a
ACA 864 @ 4oz./M^2	292 cd	413 a	436 a	318 a	156 a	69 a
ACA 864 @ 2oz./M^2	403 bc	496 a	431 a	315 a	107 a	49 a
Probability	.0009	.2846	.9862	.3749	.3457	.2314

Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 9. Effects of Wetting Agent Treatment on Water Droplet Infiltration at Various depths, Time In Seconds
Wetting agents applied August 15, 1994
Cores taken September 15, 1994

Treatments	Surface	1 cm depth	2 cm depth	3 cm depth	4 cm depth	5 cm depth
Check	502 a	465 a	323 a	319 a	279 a	270 a
AquaGro L @ 8oz./M^2	545 a	456 a	338 a	256 ab	209 a	80 b
ACA 864 @ 6oz./M^2	382 a	146 b	112 a	93 b	96 a	64 b
ACA 864 @ 4oz./M^2	423 a	233 ab	178 a	139 ab	94 a	60 b
ACA 864 @ 2oz./M^2	489 a	391 ab	222 a	178 ab	124 a	36 b
Probability	.2189	.0571	.2050	.1463	.3354	.0713

Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 10. Effects of Wetting Agent Treatment on Water Droplet
Infiltration at Various depths Time In Seconds
Wetting agents applied September 17, 1994
Cores taken October 17, 1994

Treatments	Surface	1 cm depth	2 cm depth	3 cm depth	4 cm depth	5 cm depth
Check	600 a	487 ab	351 ab	330 a	121 a	93 a
AquaGro L @ 8oz./M^2	600 a	554 a	472 a	335 a	285 a	95 a
ACA 864 @ 6oz./M^2	503 a	65 c	182 b	275 a	226 a	97 a
ACA 864 @ 4oz./M^2	421 a	71 c	140 b	230 a	133 a	65 a
ACA 864 @ 2oz./M^2	590 a	259 bc	328 ab	159 a	151 a	75 a
Probability	.1305	.0015	.0903	.5828	.1500	.7299

Means in columns followed by the same letter are not significantly different at the 5% level using Duncan's Multiple Range Test.

Table 11. Greens Rolling Study 1994

Stimpmeter Readings After Rolling - All Treatments Applied

Treatment	July 22	Aug. 1	Aug. 8
3x/week Olathe @5/32	9.2 a	9.6 a	10.0 a
3x/week Jacobsen @ 5/32	8.7 ab	8.9 cd	9.2 bc
Double cut @ 5/32	9.1 a	9.0 bc	9.6 ab
5x/week Jacobsen @ 5/32	9.2 a	9.5 ab	9.2 bc
3x/week Jacobsen @ 3/16	8.3 b	8.0 e	8.8 cd
Check cut @ 5/32	8.3 b	8.4 de	8.4 d

Means followed by the same letter are not significantly different at the 5% level using the LSD mean separation test.