# TURFGRASS SOIL MANAGEMENT RESEARCH REPORT - 1990

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This report describes research conducted in 1990 which was supported by funding from the Michigan Turfgrass Foundation and the Michigan Agricultural Experiment Station as well as several companies which provided financial support or fertilizers and topdressing materials. This support is gratefully acknowledged. This research could not have been conducted without this support.

## NITROGEN CARRIER EVALUATIONS

Several nitrogen carriers were evaluated for responses at the Hancock Turfgrass Research Center in 1990. The grass was a blend of improved Kentucky bluegrasses. Plot size was 4 feet by 12 feet. Each treatment was replicated 3 times. Carriers evaluated are listed in Table 1. Nitroform is ureaformaldehyde. Nutralene contains methylene ureas from Nor-Am. The Sierra fertilizers are plastic coated materials from the Sierra Co. The 46-0-0 is urea while the other Anderson's fertilizers, including Rejuvenate are based on natural organic sources. Ringer's fertilizer is also based on natural organic sources from the Ringer Co. Sustane is a poultry manure based product from the Sustane Corp. N-Sure is a liquid product containing triazones and urea from the Arcadian Corp. Nitro-26 is a liquid fertilizer containing various methylene ureas from Growth Products. Clipping weights were collected on three dates from an area 22 inches wide by 10 feet, 2 inches long on each plot. Clippings were dried and weighed. Nitrogen carriers were applied at 1 pound nitrogen per 1000 sq. ft. on July 9 and August 20. Turf quality ratings were taken on dates shown in Table 1.

Eight days after application (July 17) most carriers gave significant improvement in turf quality ratings compared to the untreated check. Some of the natural organics and ureaformaldehyde gave slower responses as would be expected short term. One month after application (Aug 6) most carriers responded well except for ureaformaldehyde and Sustane. Four days after the second application (Aug 24) all carriers ranked better than the check. One month after the second application (Sept 21) only Anderson's 10-2-6 and N-Sure did not outrank the check. Two months after the second application in late October, most products still had better ratings than the check. By mid-November, many carriers still had very good ratings.

Clipping weight data are given in Table 2. Urea gave the highest clipping weights on the dates evaluated. The rapid availability of the nitrogen in urea would be expected to give the highest growth responses. Such rapid growth is not considered good from a physiological perspective, however.

Table 1 Kentucky Bluegrass Fertility Study 1990
Hancock Turfgrass Research Center
Quality Ratings 9=Excellent, 1=Poor
1 pound N/M Applied July 9 and August 20, 1990

| Treatments | Rating Dates, 1990 | | | | | |
|---|---|---|---|---|---|---|
| | 7/17 | 8/6 | 8/24 | 9/21 | 10/29 | 11/16 |
| Nitroform | 6.3 bc | 6.7 de | 7.0 cd | 6.8ab | 7.2ab | 7.0 bcd |
| Nutralene | 7.0abc | 7.0 cd | 7.3 bcd | 7.0ab | 7.5a | 7.2abc |
| Sierra 34-0-7 | 6.8abc | 7.7abc | 7.3 bcd | 7.2ab | 7.7a | 8.0a |
| Sierra 25-0-0 | 7.0abc | 7.3 bcd | 7.8ab | 7.3a | 7.7a | 8.0a |
| Anderson 46-0-0 | 7.7a | 7.5abc | 8.0a | 7.3a | 7.8a | 8.0a |
| Anderson 10-2-6 | 7.7a | 7.7abc | 7.5abc | 6.5 bc | 7.2ab | 6.8 bcd |
| Anderson 5-3-3 | 7.7a | 8.2a | 8.0a | 7.0ab | 7.7a | 7.7ab |
| Rejuvenate 9-3-6 | 7.3ab | 7.7abc | 7.7ab | 6.8ab | 7.3ab | 7.0 bcd |
| Ringer 10-2-6 | 6.3 bc | 7.2 cd | 7.0 cd | 7.0ab | 7.2ab | 7.2abc |
| Sustane 5-2-4 | 6.3 bc | 6.7 de | 6.8 d | 6.7ab | 6.5 bc | 6.3 cd |
| N-Sure | 7.0abc | 7.3 bcd | 7.0 cd | 6.5 bc | 7.0abc | 6.8 bcd |
| Nitro 26 | 7.7a | 8.0ab | 7.3 bcd | 6.7ab | 7.2ab | 7.3ab |
| Check | 6.0 c | 6.0 e | 6.0 e | 6.0 c | 6.2 c | 6.2 d |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 2 Kentucky Bluegrass Fertility Study
Values expressed as grams per square meter
1 pound of N/M applied on July 9 and August 20, 1990

| Treatment | 7/18/90 | 8/6/90 | 8/31/90 |
|---|---|---|---|
| Nitroform | 0.8 f | 23.87ab | 5.0 bc |
| Nutralene | 1.0 f | 28.36ab | 7.3 bc |
| Sierra 34-0-7 | 1.2 def | 30.65ab | 6.6 bc |
| Sierra 25-0-0 | 2.0 bcdef | 31.94ab | 7.8 b |
| Anderson 46-0-0 | 4.8a | 38.74a | 11.7a |
| Anderson 10-2-6 | 3.0 b | 36.09a | 5.2 bc |
| Anderson 5-3-3 | 2.5 bcde | 35.70a | 8.4ab |
| Rejuvenate 9-3-6 | 2.7 bc | 36.36a | 7.4 bc |
| Ringer 10-2-6 | 1.4 cdef | 37.79a | 8.3ab |
| Sustane 5-2-4 | 1.4 cdef | 25.76ab | 5.0 bc |
| N-Sure | 2.5 bcde | 29.51ab | 5.6 bc |
| Nitro 26 | 2.6 bcd | 30.98ab | 7.6 b |
| Check | 1.1 ef | 19.22 b | 3.5 c |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

## EFFECTS OF MANGANESE APPLICATIONS ON TURFGRASS QUALITY

Among the micronutrient required for plant growth, iron is used most widely on turfgrasses to improve turf color even though an iron deficiency has not been observed in Michigan. Manganese is suggested as another micronutrient to which turfgrasses might be responsive under certain conditions. In Michigan, many soils test moderately low to low in available manganese, particularly some of the finer-textured soils in eastern Michigan which have Ph levels well above 7.0. A few companies which sell fertilizers recommend the application of manganese on many turfs in Michigan. With these points in mind, we initiated a study at the Hancock Turfgrass Research Center to evaluate the effect of applications of manganese on a Penncross creeping bentgrass green. Treatments applied are given in Table 3. Manganese sulfate was applied at the rate of 1 or 2 ounces per 1000 sq. ft. on the dates shown. For comparison purposes, ferrous sulfate was applied at 2 ounces on the same dates. There was also an untreated check. Plot size was 4 feet by 6 feet. There were 3 replications of each treatment.

Applications of iron consistently provided the best quality turf. On some dates there were no differences among treatments. There appeared to be no consistent benefit from the application of manganese on this putting green.

A separate study was established in August on the putting green to determine if there was any phytotoxicity caused by the application of manganese. In this case treatments were not watered in. Data in Table 4 indicate there was no phytotoxicity from the manganese applications. Buy contrast, 2 ounces of ferrous sulfate caused some phytotoxicity. While foliar applications of iron sulfate have been used for years to improve turf quality, it is clear that too frequent use or applications at too high rates can result in reduced turf quality. When using iron to improve turf color, watch for leaf tip burn in particular.

## TOPDRESSING STUDIES

A topdressing study was established in 1986 on a Penncross creeping bentgrass green at the Hancock Turfgrass Research Center. Treatments applied are outlined in Table 5. Materials applied are sand; 80% sand with 20% peat; and 60% sand with 20% peat and 20% loam soil. Each was applied under two topdressing programs: either twice annually (spring and fall) at the rate of 12 cu. ft. per 1000 sq. ft. (referred to as heavy and infrequent) or at 3 cu. ft. per 1000 sq. ft. every 3 weeks during the growing season (referred to light and frequent program). One other set of plots was aerified both spring and fall followed by application of sand at the 12 cu. ft. rate. There was also an untreated plot (Check). There were 3 replications of each treatment.

After 5 years of treatment, generally consistent patterns in turf quality ratings continue to occur. Most years turf quality has improved after topdressing whether for the light and frequent

Table 3 Manganese Sulfate Study
Color Ratings 9 = Dark Green 1 = Pale Green
Initiated July 25, 1990
Treatments Applied, 7/25, 8/10, 8/23, 1990

| Treatment | Rate oz/M | Rating Dates | | | | | |
|---|---|---|---|---|---|---|---|
| | | 7/25 | 8/10 | 8/13 | 8/15 | 8/24 | 8/27 |
| $MnSO_4$ | 1 | 7.5a* | 8.2a | 8.0ab | 8.0ab | 7.5 c | 7.5 b |
| $MnSO_4$ | 2 | 7.8a | 8.0ab | 7.5 b | 7.5 b | 7.6 bc | 7.2 b |
| $FeSO_4$ | 2 | 8.5a | 8.5a | 8.5a | 8.5a | 8.6a | 8.2a |
| Check | --- | 7.5a | 7.2 b | 7.5 b | 7.8ab | 8.0 b | 7.4 b |

* - Means followed by the same letter are not significantly different at the 10% level using Duncan's Multiple Range Test.

Table 4 Manganese Sulfate Study
Unwatered Treatment Evaluation, Burn and Quality
Treated, August 23, 1990
Burn, 9=dead, 1=No Burn, Quality, 9=Excellent, 1=Poor

| Treatment | Rate oz/M | Rating Date August 24, 1990 | |
|---|---|---|---|
| | | Burn Rating | Quality Rating |
| $MnSO_4$ | 1 | 1.5 b* | 7.2a |
| $MnSO_4$ | 2 | 1.0 b | 7.1a |
| $FeSO_4$ | 2 | 2.8a | 7.6a |
| Check | --- | 1.0 b | 7.1a |

* - Means followed by the same letter are not significantly different at the 10% level using Duncan's Multiple Range Test.

Table 5 Great Lakes Topdressing Study
Initiated 1986
Clipping Yields per Square Meter

| Treatment | Rate | Frequency | 7/18 | 10/21 |
|---|---|---|---|---|
| Sand | 3 $ft^3$ | 3 Weeks | 34.64ab | 5.1 b |
| Sand | 12 $ft^3$ | Spring/Fall | 30.88 b | 6.0 b |
| 80 sand 20 Peat | 3 $ft^3$ | 3 Weeks | 40.50ab | 6.5 b |
| 80 Sand 20 Peat | 12 $ft^3$ | Spring/Fall | 38.95ab | 6.1 b |
| 60 Sand 20 Peat 20 Soil | 3 $ft^3$ | 3 Weeks | 33.02ab | 6.5 b |
| 60 Sand 20 Peat 20 Soil | 12 $ft^3$ | Spring/Fall | 46.56a | 7.2 b |
| Sand and Aerified | 12 $ft^3$ | Spring/Fall | 30.62 b | 7.0 b |
| Check | ----- | | 36.00ab | 11.46a |

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

has improved after topdressing whether for the light and frequent program or for the spring and fall program. The data in 1990 were similar for the most part. The most consistent turf quality ratings were for the light and frequent programs which is consistent with previous years. At times the Check plots ranked equal to other treatments, but for several dates the Check plots had clearly inferior ratings. The thatch accumulation in the Check plots resulted in puffy conditions and scalping at times during the season. The light and frequent programs have produced uniform soil conditions as well in the layer developed since the initiation of the study. Plots receiving spring and fall topdressings at the higher rate have developed layers as would be expected with infrequent topdressing at heavy rates. On some dates in other years plots receiving some soil in the topdressing material have rated as good or better than when sand alone was applied. This did not occur in 1990, however. On two dates, clipping weights were collected (data not shown). There were no meaningful differences observed in clipping weights. This study will continue for 2 more years to determine the longer term impact of these treatments. Over the short term (3 years or so) almost any topdressing program might be reasonably successful. In most cases, it is only after many years that the true effect of a topdressing program would begin to appear.

## CULTIVATION STUDIES

A study to evaluate the effect of timing of cultivation of annual bluegrass fairway turf was initiated in 1989 at the Hancock Turfgrass Research Center. Dates of cultivation are given in Table 6. Our hypothesis is that cultivation after seedhead production may enhance rooting while cultivation in mid-summer may be increase susceptibility to stress. Plot size is 6 ft. by 10 ft. with 3 replications. Turf quality ratings indicate there were no meaningful differences in the appearance of the turf in 1990. We will be evaluating thatch and rooting responses in future years. This is a cooperative study with J. M. Vargas, Jr.

Another cultivation study on the effect of cultivation programs on turf quality and thatch conditions was established in 1987 on a block of Ram-I Kentucky bluegrass at the Hancock Turfgrass Research Center. The turf had a significant thatch layer at the initiation of the study. Treatments include solid and hollow tine cultivation aerification with large, medium and small equipment. Because of stones in the soil no soil density or pore size distribution measurement will be taken, but effects on thatch will be determined. Samples were obtained from each plot in the fall of 1990. Data are not yet available from these samples. Visual examination of the thatch layer reveals that when aggressive core cultivation with hollow tines leaves the thatch well intermixed with soil. Solid tine cultivation brings no soil to the surface so the thatch layer is intact on plots aerified with solid tines.

Table 6 Cultivation Timing Study
1990 Quality Ratings
Initiated June 7, 1989, Hancock Turfgrass Research Center

| Treatment | Rating Dates | | | | |
|---|---|---|---|---|---|
| | 6/29 | 7/17 | 8/13 | 9/21 | 10/25 |
| Early Spring April 15 | 8.0a* | 8.0a | 7.5a | 7.0a | 7.2a |
| After Poa Seedheads June 15 | 7.2a | 8.0a | 7.4a | 7.5a | 7.5a |
| High Stress July 15 | 7.8a | 7.5ab | 7.6a | 7.2a | 7.2a |
| Fall September 15 | 7.8a | 8.0a | 7.5a | 7.5a | 7.2a |
| Late Fall November 1 | 7.5a | 7.2 b | 7.6a | 7.5a | 7.0a |
| Check | 7.5a | 7.8ab | 8.0a | 7.5a | 7.0a |

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

## EFFECT OF HIGH POTASSIUM RATES ON TURF AND SOIL TESTS

Over the past few years there has been a significant increase in the amount of potash applied to many turfs, particularly on golf courses. There is concern that too high rates of potash could be used on some turfs resulting in nutrient imbalances or high salt levels in the soil. With this in mind, three studies were initiated in 1990 at the Hancock Turfgrass Research, one each on Bristol bluegrass growing on loam soil, annual bluegrass growing on loam soil and Penncross creeping bentgrass under maintained under greens conditions. Treatments applied included rates of 0, 4, 8 and 12 lbs. potash per 1000 sq. ft. applied annually as potassium chloride (0-0-60). One other treatment was 12 lbs. potash applied as potassium sulfate. On each turf there was also one treatment where potash was applied at rates recommended by soil tests. These rates were: 5.5 lbs. potash applied on the bentgrass; 3.0 lbs. on the Kentucky bluegrass; and 3.5 lbs. potash on the annual bluegrass. Potash treatments were applied at rates of no more than 2.0 lbs. per 1000 sq. ft. per application in one application. Plot size was 4 ft. by 6 ft. with 3 replications of each treatment.

There were no observable differences in turf quality on any of the grasses during the year. Soil samples were collected in late October to determine the effect of potash fertilization program on available levels of potassium, calcium and magnesium. Samples were obtained from the 0-3 and 3-6 inch depths. Data for the soil tests are given in Tables 7 through 9 for the K, Ca and Mg tests on the Kentucky bluegrass plots, respectively. There is a clear response in soil K tests (Table 7) on this soil which has a medium level of available K. For no apparent reason the 4 lb. potash treatment tested higher in K than the 8 lb. treatment. Otherwise, the results are about as would be expected There were no effects on Ca or Mg tests in this first year.

On the annual bluegrass plots the K tests (Table 10) on the check plots was lower than on the Kentucky bluegrass plots. Again there was a clear response to the K applications. Small differences were even seen in the 3-6 inch depth on this soil. There was no difference in Ca soil tests (Table 11), but Mg tests dropped under higher rates of potash in the 0-3 inch depth (Table 12).

The soil K tests for putting green soil (Table 13) were much lower than on the soils with more silt and clay. Sands have very little cation exchange capacity to attract and hold the K. As a result, potassium will be more susceptibility to leaching. There was a clear response to the applied potash in the 0-3 inch depth as well as in the 3-6 inch depth. There were no significant differences in available Ca tests (Table 14) or in the 0-3 inch depth for Mg tests (Table 15). There was some evidence of a reduction in the Mg tests in the 3-6 inch depth with the higher K rates, however. In sandy soils, the K can move more readily into the lower depths which could result in replacement of some of the Mg in the soil.

Table 7 1990 High Potassium Study
Soil Potassium Levels, Bristol Kentucky Bluegrass,Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 145 d* | 253 |
| Soil Test 3.5 | KCL | 292 c | 103 |
| 4.0 | KCL | 360 b | 116 |
| 8.0 | KCL | 282 c | 94 |
| 12.0 | KCL | 465a | 145 |
| 12.0 | $K_2SO_4$ | 458a | 149 |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 8 1990 High Potassium Study
Soil Calcium Levels, Bristol Kentucky Bluegrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 2040 | 1400 |
| Soil Test 3.5 | KCL | 1920 | 1060 |
| 4.0 | KCL | 2000 | 1280 |
| 8.0 | KCL | 2040 | 1163 |
| 12.0 | KCL | 1980 | 1222 |
| 12.0 | $K_2SO_4$ | 2000 | 1020 |

Table 9 1990 High Potassium Study
Soil Magnesium Levels, Bristol Kentucky Bluegrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 360a* | 270 |
| Soil Test 3.5 | KCL | 352ab | 260 |
| 4.0 | KCL | 354ab | 260 |
| 8.0 | KCL | 330ab | 274 |
| 12.0 | KCL | 320ab | 256 |
| 12.0 | $K_2SO_4$ | 310 b | 244 |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 10 1990 High Potassium Study
Soil Potassium Levels, Annual Bluegrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 90 c* | 70 b |
| Soil Test 3.5 | KCL | 238 b | 104a |
| 4.0 | KCL | 200 b | 88ab |
| 8.0 | KCL | 191 b | 86ab |
| 12.0 | KCL | 406a | 100a |
| 12.0 | $K_2SO_4$ | 392a | 110a |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 11 1990 High Potassium Study
Soil Calcium Levels, Annual Bluegrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 1867 | 1562 |
| Soil Test 3.5 | KCL | 1810 | 1619 |
| 4.0 | KCL | 1752 | 1505 |
| 8.0 | KCL | 1772 | 1486 |
| 12.0 | KCL | 1810 | 1486 |
| 12.0 | $K_2SO_4$ | 1829 | 1581 |

Table 12 1990 High Potassium Study
Soil Magnesium Levels, Annual Bluegrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 340a* | 304 |
| Soil Test 3.5 | KCL | 325ab | 296 |
| 4.0 | KCL | 321ab | 288 |
| 8.0 | KCL | 319ab | 296 |
| 12.0 | KCL | 303 b | 286 |
| 12.0 | $K_2SO_4$ | 311 b | 296 |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 13 1990 High Potassium Study
Soil Potassium Levels, Penncross Creeping Bentgrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 46 c* | 34 c |
| Soil Test 3.5 | KCL | 118 b | 108a |
| 4.0 | KCL | 130 b | 60 b |
| 8.0 | KCL | 112 b | 60 b |
| 12.0 | KCL | 222a | 118a |
| 12.0 | $K_2SO_4$ | 222a | 114a |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

Table 14 1990 High Potassium Study
Soil Calcium Levels, Penncross Creeping Bentgrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 990 | 838 |
| Soil Test 3.5 | KCL | 971 | 819 |
| 4.0 | KCL | 1009 | 819 |
| 8.0 | KCL | 971 | 762 |
| 12.0 | KCL | 1010 | 762 |
| 12.0 | $K_2SO_4$ | 952 | 762 |

Table 15 1990 High Potassium Study
Soil Magnesium Levels, Penncross Creeping Bentgrass, Samples Collected November 16, 1990, HTRC.

| Treatment lbs $K_2O$/M | K Source | 0-3 inches lbs/Acre | 3-6 inches lbs/Acre |
|---|---|---|---|
| 0.0 | KCL | 149 | 140a* |
| Soil Test 3.5 | KCL | 134 | 116ab |
| 4.0 | KCL | 130 | 123ab |
| 8.0 | KCL | 139 | 120ab |
| 12.0 | KCL | 128 | 116ab |
| 12.0 | $K_2SO_4$ | 122 | 112 b |

* - Means followed by the same letter are not significantly different at the 5% level using Duncans Multiple Range Test.

The continued use of very high K rates could result in leaching of Mg. On sandy soils it is especially important to monitor soil Mg tests when using high K rates. Since many water sources come from limestone aquifers which contain some Mg, this may not present a problem where such water is used for irrigation. We have consistently observed increases in soil Mg tests on such sites. While increased use of potash is considered important because of improvement in wear and stress tolerance, turf managers should also be aware of potential problems with overuse of potash. Soil tests should be used more frequently when applying high rates of potash (5-6 lbs. per 1000 sq. ft. annually), especially on sands.

## WETTING AGENT STUDIES

There are several new wetting agent products which have become commercially available in the past several years. We have received many questions about the efficacy of these newer products. In order to learn more about some of these newer products, we established wetting agent trials on 3 turf sites in 1990. For several years we have had studies in East Lansing to evaluate wetting agent materials, but had very limited success because we could not develop the hydrophobic conditions over a long enough period of time to evaluate the wetting agents. When the dry spot conditions began to appear, rains would rewet the soil such that no differences occurred among treatments. So in 1990 we selected 3 sites in different locations in the state, thinking surely one of these areas would experience dry enough weather that localized dry spots would develop on at least on of the sites. The studies were established on: 1)the putting green growing on a loamy sand soil at the Hancock Turfgrass Research Center; 2) on a fairway at the Crystal Downs Country Club near Frankfort; and 3) on a fairway at the Pines Golf Course near Mount Pleasant. Both fairways were growing on sandy soils. Wetting agents applied and the application schedules are given in Tables 16, 17 and 18, respectively, for the 3 sites. Five treatment dates were utilized on the plots in East Lansing and 3 treatment dates (on a monthly basis) at the other 2 locations. All treatments were watered in after application. There were 3 replications of each treatment.

In spite of our efforts to establish plots in 3 widely diverse locations in the state, 1990 was not the year to study localized dry spot problems. On a few occasions it appeared as if some differences were about to develop, then rains masked those differences very quickly. Unfortunately, this occurred at all 3 locations. As a result there were no visible differences among any of the treatments. Soil samples were obtained at all 3 locations to determine if there were any soil effects due to wetting agents. In previous studies we have observed that effective wetting agents permitted rewetting of the hydrophobic soil conditions. This resulted in higher soil moisture following irrigation than when the dry condition remained. In the 3 studies established in 1990, there were no consistent differences due to treatment. This again, was a result of the relatively wet summer.

Table 16 1990 Wetting Agent Study
Soil Moisture Measurements by depth, % moisture by weight
Treatments applied 7/10, 7/24, 8/13, 8/27, 9/7, 1990
Hancock Turfgrass Research Center

| Treatment | Rate/M | 0-5 cm Depth | 5-10 cm Depth |
|---|---|---|---|
| LescoWet | 2 oz | 20.8a* | 12.8ab |
| LescoWet | 4 oz | 18.0abcd | 12.1abc |
| LescoWet | 8 oz | 18.7abcd | 13.6ab |
| LescoWet Granular | 2.5 lbs | 16.7abcd | 11.5abc |
| LescoWet Granular | 5.0 lbs | 17.6abcd | 12.0abc |
| Aqua-Gro Liquid | 2 oz | 19.2ab | 13.0ab |
| Aqua-Gro Liquid | 4 oz | 17.3abcd | 11.3abc |
| Aqua-Gro Granular | 3.5 lbs | 18.6abcd | 13.1ab |
| Aqua-Gro Granular | 7.0 lbs | 19.0abc | 12.9ab |
| Hydraflo liquid | 2 oz | 13.3 d | 9.3 c |
| Hydraflo liquid | 4 oz | 17.8abcd | 11.8abc |
| Hydraflo granular | 3.5 lbs | 14.2 cd | 10.5 bc |
| Hydraflo granular | 7.0 lbs | 18.7abcd | 13.2ab |
| Hydrozyme | 12 oz | 15.0 bcd | 10.4 bc |
| Naiad | 4 oz | 20.1ab | 12.8ab |
| Surfside 19A | 6 oz | 19.5abc | 12.4abc |
| Surfside 37 | 6 oz | 15.9abcd | 10.8abc |
| Check | | 20.1ab | 13.9a |

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

Table 17 1990 Wetting Agent Study
Soil Moisture Measurements by depth, % moisture by weight
Initiated July 2, 1990, monthly treatments
Crystal Downs Country Club, Frankfort, Michigan

| Treatment | Rate/M | 0-5 cm Depth | 5-10 cm Depth |
|---|---|---|---|
| Surfside 19a | 6 oz | 32.6ab* | 19.2a |
| Surfside 37 | 6 oz | 31.3ab | 19.6a |
| Aqua-Gro Liquid | 8 oz | 36.2a | 19.2a |
| Aqua-Gro Granular | 3.5 lbs | 31.1ab | 20.3a |
| Hydroflo | 2 oz | 30.2 b | 19.5a |
| LescoWet Liquid | 4 oz | 30.2 b | 19.8a |
| LescoWet Liquid | 8 oz | 31.6ab | 19.3a |
| LescoWet Granular | 2.5 lbs | 31.4ab | 18.1a |
| LescoWet Granular | 5.0 lbs | 30.9ab | 19.6a |
| Hydrozyme | 12 oz | 30.5a | 20.4a |
| Naiad | 4 oz | 31.6ab | 20.2a |
| Check | | 32.0ab | 18.9a |

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

Table 18 1990 Wetting Agent Study
Soil Moisture Measurements by depth, % moisture by weight
Initiated July 2, 1990, monthly treatments
The Pines Golf Course, Mount Pleasant, Michigan

| Treatment | Rate/M | 0-5 cm Depth | 5-10 cm Depth |
|---|---|---|---|
| Surfside 19a | 6 oz | 22.6ab* | 16.6a |
| Surfside 37 | 6 oz | 22.8ab | 17.3a |
| Aqua-Gro Liquid | 8 oz | 22.3ab | 17.5a |
| Aqua-Gro Granular | 3.5 lbs | 22.1ab | 16.9a |
| Hydroflo | 2 oz | 23.0ab | 17.1a |
| LescoWet Liquid | 4 oz | 22.2ab | 16.9a |
| LescoWet Liquid | 8 oz | 23.4ab | 17.8a |
| LescoWet Granular | 2.5 lbs | 25.3a | 17.4a |
| LescoWet Granular | 5.0 lbs | 20.6b | 16.8a |
| Hydrozyme | 12 oz | 22.4ab | 16.1a |
| Naiad | 4 oz | 24.2ab | 16.2a |
| Check | | 25.5a | 16.3a |

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

Table 19

1990 Wetting Agent Study
Dew Ratings, 9 = no dew, 1 = heavy dew
Treatments applied 7/10, 7/24, 8/13, 8/27, 9/7, 1990
Hancock Turfgrass Research Center

| Treatment | Rate/M | Rating Dates, 1990 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 7/16 | 7/25 | 7/27 | 8/8 | 8/14 | 8/17 | 8/24 | 8/29 | 9/12 | 9/26 |
| LescoWet | 2 oz | 2.7egf* | 7.0ab | 5.7ab | 1.3a | 8.0a | 2.3def | 1.0b | 3.3ab | 1.3ef | 1.0c |
| LescoWet | 4 oz | 3.3cdef | 8.3a | 6.0a | 1.7a | 9.0a | 1.7ef | 1.0b | 5.0ab | 3.0cde | 1.0c |
| LescoWet | 8 oz | 4.3bcd | 8.7a | 6.0a | 1.3a | 9.0a | 4.0bcd | 1.0b | 4.7ab | 1.7ef | 1.0c |
| LescoWet Granular | 2.5 lbs | 2.7efg | 1.0d | 1.3d | 1.3a | 6.0e | 2.0def | 1.0b | 1.0b | 1.3ef | 1.0c |
| LescoWet Granular | 5.0 lbs | 1.7gh | 1.0d | 1.3d | 1.3a | 6.3de | 1.0f | 1.0b | 2.3b | 1.3ef | 1.0c |
| Aqua-Gro Liquid | 2 oz | 3.0defg | 6.0bc | 6.0a | 1.7a | 8.7ab | 2.7cdef | 1.0b | 4.0ab | 1.3ef | 1.0c |
| Aqua-Gro Liquid | 4 oz | 4.0bcde | 8.0a | 5.7ab | 1.3a | 9.0a | 4.7abc | 1.0b | 5.0ab | 3.0cde | 1.0c |
| Aqua-Gro Granular | 3.5 lbs | 2.7efg | 1.3d | 1.3d | 1.0a | 7.3bcde | 3.0bcdef | 1.0b | 3.0ab | 2.3def | 1.0c |
| Aqua-Gro Granular | 7.0 lbs | 4.7bc | 2.3d | 2.7cd | 1.3a | 8.0abc | 5.0ab | 1.0b | 1.0b | 3.7cd | 1.3bc |
| Hydraflo liquid | 2 oz | 4.0bcde | 8.7a | 6.7a | 1.7a | 9.0a | 3.7bcde | 1.3b | 4.7ab | 2.7cdef | 1.0c |
| Hydraflo liquid | 4 oz | 5.0b | 8.0a | 6.7a | 2.0a | 9.0a | 4.7abc | 1.0b | 7.0a | 4.3bc | 1.0c |
| Hydraflo granular | 3.5 lbs | 5.0b | 1.3d | 2.7cd | 1.3a | 7.0cde | 3.7bcde | 1.0b | 2.3b | 5.7ab | 1.7b |
| Hydraflo granular | 7.0 lbs | 6.7a | 1.3d | 2.3cd | 1.3a | 8.0abc | 6.7a | 3.0a | 3.0ab | 7.3a | 2.7a |
| Hydrozyme | 12 oz | 2.0fgh | 1.3d | 2.0d | 1.7a | 7.7abcd | 2.3def | 1.0b | 1.0b | 2.7cdef | 1.0c |
| Naiad | 4 oz | 2.7efg | 4.7c | 4.0d | 1.0a | 9.0a | 3.0bcdef | 1.3b | 3.7ab | 1.3ef | 1.0c |
| Surfside 19A | 6 oz | 2.3fgh | 1.7d | 1.3d | 1.0a | 7.7abcd | 3.0bcdef | 1.0b | 1.0a | 1.3ef | 1.0c |
| Surfside 37 | 6 oz | 2.7efg | 1.0d | 1.0d | 1.3a | 7.7abcd | 2.3def | 1.0b | 1.3b | 1.3ef | 1.0c |
| Check | | 1.0h | 1.0d | 1.7d | 1.7a | 6.0e | 2.7cdef | 1.0b | 1.0ab | 1.0f | 1.0c |

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

The only observable differences due to treatment in East Lansing were in the effect of wetting agent on dew (or guttation fluid) which occurred. Dew ratings for these plots are given in Table 19. Among liquid materials Lescowet, Aqua-Gro and Hydraflo tended to be the most effective in reducing dew rating. Granular formulations were much slower to affect dew formation and were generally less effective.

## EARLY SPRING MOWING STUDY

As reported last year mowing a Kentucky bluegrass turf early in the spring before growth initiation resulted in improved turf ratings on several dates during the growing season. This study was repeated in 1990. The Kentucky bluegrass sod was mowed on March 16 at heights of 0.5, 1.0, 1.5 and 2.0 inches with a rotary mower. All material was removed from the plot area. Turf quality ratings were taken at several times during the growing season as shown in Table 20. Early in the growing season (April) the shortest mowing height gave the best turf ratings. After that time few differences occurred. This was consistent with data taken in 1989. We are still of the opinion that removing the dead leaf tissue early in the spring permits quicker warming of the soil and crown tissue, resulting in earlier growth initiation. While this practice has limited application, it may be feasible on sites where early spring greenup is desired beyond that achieved by fertilization.

Table 20

Early Mowing Study
Quality Ratings, 9 = Best, 1 = Poor
Initiated March 16, 1990

| Treatments | 5/31[1] | 3/28 | 4/3 | 4/13 | 4/23 | 5/10 | 5/25 | 6/20 | 7/20 | 8/22 | 9/22 | 10/18 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| no mowing | 78.6a* | 2.5b | 2.0c | 2.0d | 3.0d | 6.4ab | 7.2ab | 6.0b | 4.5a | 7.4bc | 7.5a | 7.6a |
| 0.5 inch | 27.8 b | 2.2b | 5.2a | 5.0a | 6.2a | 5.8b | 5.8c | 6.4ab | 4.5a | 8.1a | 7.6a | 7.6a |
| 1.0 inch | 27.3 b | 3.2a | 3.5b | 4.2b | 5.2b | 5.8b | 6.2bc | 6.8a | 5.2a | 7.8ab | 7.8a | 7.2a |
| 1.5 inch | 52.2ab | 2.2b | 2.5c | 3.0c | 3.8c | 6.5a | 7.2ab | 6.0b | 5.2a | 7.2bc | 7.8a | 7.1a |
| 2.0 inch | 77.9a | 2.2b | 2.0c | 2.2d | 3.3cd | 6.6a | 7.5a | 6.0b | 5.0a | 7.1c | 7.8a | 7.5a |

1 - clipping weight
* - means followed by the same letter are not significantly different at the 5% level using Duncan's multiple range test.