# DEVELOPMENT OF CULTIVATION PROGRAMS ON TURFGRASS TO REDUCE WATER USE AND IMPROVE TURF QUALITY

UNIVERSITY OF GEORGIA
Griffin, GA

Dr. Robert N. Carrow
Principal Investigator

1991 Research Grant: $18,000
(third year of support)

Adverse soil physical conditions interfere with turfgrass management by limiting water movement, reducing plant water uptake, reducing soil aeration, and decreasing root/shoot growth. Compaction of the soil surface and excessively fine-textured (i.e. high in clay and silt content) soil profiles are two of the most common adverse soil physical properties. Cultivation is a primary means of alleviating these problems; however, comparative research studies to evaluate different techniques have not been conducted. The objectives of this project were (a) to evaluate different cultivation techniques for their relative effectiveness in alleviating soil compaction, improving water use efficiency, and improving shoot/root growth, and (b) to develop "cultivation" programs for fairway/tee conditions based on using two or more different cultivation techniques.

Phase I (1989-1990) of this project focused on objective (a) and was summarized in the 1990 annual report; but new cultivation techniques will still be evaluated over the last two years (1991-1992). The primary focus in 1991 through 1992, however, will be to evaluate cultivation programs (i.e., objective b).

Seven cultivation treatments plus two control treatments are under investigation in the 1991-1992 study (Table 1). From the previous study in Phase I, the most effective cultivation technique for deeper in the soil profile was the Verti-Drain, while hollow tine coring improved surface conditions. Thus, intensity of Verti-Drain treatment (i.e., 1x, 2x times over the plot area), as well as, Verti-Drain plus hollow-tine coring combinations are being explored. The Yeager-Twose Turf Conditioner (a subaerification unit) has not been evaluated in research studies for comparative effectiveness as a turfgrass cultivation unit. The vibrating shank goes to a depth of 7 inches and with proper attachments can inject granular components to this depth.

The soil is a Cecil sandy clay loam with 55.1% sand, 17.6% silt, 27.3% clay and 2.14% organic matter content. A common bermudagrass mowed at 0.75 to 1.0 inch was used.

Considerable data has been collected and is under preparation and analysis related to soil physical and chemical properties by depth, water use and extraction patterns by depth, and root growth by soil depth. Shoot responses in 1991 revealed improved turf quality and shoot density from Turf Conditioner + Gypsum and Verti-Drain + Core Aeration treatments. Late summer shoot growth rate was enhanced by Turf Conditioner + Gypsum and Verti-Drain cultivation. The fact that improvements in visual quality, shoot density, color, and shoot growth rate occurred for the Turf Conditioner + Gypsum treatment but not Turf Conditioner alone implies a significant response to Gypsum. Gypsum has the potential to reduce Al root phytotoxicity on these soils.

November 1991

**Annual Progress Report**

# DEVELOPMENT OF CULTIVATION PROGRAMS ON TURFGRASS TO REDUCE WATER USE AND IMPROVE TURF QUALITY

UNIVERSITY OF GEORGIA
Griffin, Georgia

Dr. Robert N. Carrow
Principal Investigator

1991 Research Grant: $18,000
(third year of support)

Adverse soil physical conditions interfere with turfgrass management by limiting water movement, reducing plant water uptake, reducing soil aeration, and decreasing root/shoot growth. Compaction of the soil surface and excessively fine-textured (i.e. high in clay and silt content) soil profiles are two of the most common adverse soil physical properties. Cultivation is a primary means of alleviating these problems; however, comparative research studies to evaluate different techniques have not been conducted.

The objectives of this project were (a) to evaluate different cultivation techniques for their relative effectiveness in alleviating soil compaction, improving water use efficiency, and improving shoot/root growth, and (b) to develop "cultivation" programs for fairway/tee conditions based on using two or more different cultivation techniques.

Phase I (1989-1990) of this project focused on objective (a) and was summarized in the 1990 annual report; but new cultivation techniques will still be evaluated over the last two years (1991-1992). The primary focus in 1991 through 1992, however, will be to evaluate cultivation programs (i.e., objective b).

Seven cultivation treatments plus two control treatments are under investigation in the 1991-1992 study (Table 1). From the previous study in Phase I, the most effective cultivation technique for deeper in the soil profile was the Verti-Drain, while hollow tine coring improved surface conditions. Thus, intensity of Verti-Drain treatment (i.e. 1X, 2X times over the plot area), as well as Verti-Drain plus hollow-tine coring combinations are being explored.

The Yeager-Twose Turf Conditioner (a subaerification unit) has not been evaluated in research studies for comparative effectiveness as a turfgrass cultivation unit. The vibrating shank goes to a depth of 7 inches and with proper attachments can inject granular components to this depth. Since high aluminum (Al) saturation of the cation exchange complex of Piedmont soils is a major cause of limited rooting, injection of gypsum or lime should be of benefit. Gypsum was included since it has higher solubility than lime. Also, these soils have a high bulk density (i.e., soil strength), especially in the B horizon. The Turf Conditioner thus has the potential for both physical and chemical modification of the soil.

All plots except the noncompacted control was compacted with a smooth power roller at near soil saturation on 4 April (30X = 30 times per plot area), 23 April (4X), and 27 May (3X) 1991. The soil is a Cecil sandy clay loam with 55.1% sand, 17.6% silt, 27.3% clay and 2.14% organic matter content. A common bermudagrass mowed at 0.75 to 1.0 inch was used.

Initial cultivation treatments (Verti-Drain, Turf Conditioner) were made on 26-30 April and repeated on 29 July 1991. Core aeration applications were on 11 June and 14 August 1991. Gypsum and

lime injection was achieved at 72 lb and 90 lbs per 1000 $ft^2$, respectively, at the April treatment. This was an adequate rate so these were not injected again in August. Descriptions of the cultivation methods are: (a) Verti-Drain. Solid tines of 12 in length, 0.50 in dia., spaced at 6 x 3 inch grid. (b) Core aeration. Hollow tines of 3 in. length, 0.63 inch dia., 2x2 inch grid. Cores returned after breaking up with a verticutter, and (c) Turf-Conditioner. Vibrating blades 7 inch keep on 10-inch centers. Appreciation is expressed to Russ Baker of Turf Care Concepts, Conyers, Georgia for Verti-Drain application and Russ Hill of Hendrix and Dail, Inc., Tifton, Georgia for Turf Conditioner treatment.

A summary of results to date is:

The most reasonable treatment comparison is for a cultivation treatment to be compared to the compacted control. Using this approach, Turf Conditioner + Gypsum resulted in significantly improved quality in the 17 June to 19 July period, while Verti-Drain (2X) + Core Aeration plots exhibited higher quality in late August (Table 1). Several cultivation treatments caused a temporary decline in quality following treatment application; for example, Verti-Drain (1X) on 24 May, Verti-Drain (1X, 2X) + Core Aeration on 17 June, Turf Conditioner alone, 24 May and 8 August, and Turf Conditioner + Lime on 8 August. The shoot density data (Table 2) indicate that most increases and decreases in visual quality were due to shoot density changes which mirrored visual quality results.

Relative to the compacted control, Turf Conditioner + Gypsum and Verti-Drain (1X) treatments resulted in higher clipping yields in late August (Table 3). The Turf Conditioner + Gypsum combination also improved turfgrass color on several dates (Table 4). By late August, Verti-drain 2X alone and Verti-Drain 2X + Core Aeration exhibited better color.

Significant shoot responses (visual quality, density, color, clipping yield) of the Turf Conditioner + Gypsum versus the Turf Conditioner alone indicate chemical modification is sufficient to influence shoot growth. Soil samples have been obtained by depth on 30 October to determine gypsum and lime effects on pH and extractable Al, Ca, Mg, K.

In terms of soil physical properties, saturated hydraulic conductivity measurement on 8 August revealed significantly higher water conductivity for the Verti-Drain (1X) + Core Aeration treatment compared to the compacted control. Penetrometer resistance by depth (5,10,15,20,25,30 cm) was determined on 21 June, 18 July, and 25 September. Saturated hydraulic conductivity was measured on 30 October, and bulk density/moisture retention of the surface 0-3 cm zone on November 6. These data are under analysis.

Water use and water extraction by soil depth have been determined over several dry-down periods. Also, root samples by soil depth were obtained on 5 July and 19 September. These samples and data are in preparation.

Table 1. Visual quality as influenced by cultivation treatment in 1991.

| Treatment Description | | | | Visual Quality | | | | | | Leaf Firing |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 24 | 17 | 19 | 8 | 29 | 12 | 12 |
| Device | Application[b] | | Compaction | May | Jun | Jul | Aug | Aug | Sep | Sep |
| | | | | 9=ideal density,color,uniformity;1=no live turf | | | | | | — % — |
| Control | - | - | No | 7.1abc | 6.6cd | 7.2c | 7.1a | 7.6c | 7.3c | 9.3ab |
| Control | - | - | Yes | 7.4ab | 7.0bc | 7.5cb | 7.3a | 7.7bc | 7.5abc | 12.0ab |
| Turf Cond. | Apr. 1X | Jul 1X | Yes | 6.9c | 6.8c | 7.4cb | 6.1c | 7.6c | 7.5abc | 10.8ab |
| Turf Cond. + Gypsum | Apr. 1X | Jul 1X | Yes | 7.5a | 7.8a | 8.0a | 7.2a | 8.0ab | 7.6abc | 11.3ab |
| Turf Cond. + Lime | Apr. 1X | Jul 1X | Yes | 7.3abc | 6.9bc | 7.6b | 6.5bc | 7.6c | 7.4bc | 12.8a |
| Verti-Drain | Apr. 1X | Jul 1X | Yes | 6.9c | 6.6cd | 7.6b | 7.5a | 8.0ab | 7.7a | 8.0ab |
| Verti-Drain | Apr. 2X | Jul 2X | Yes | 7.2abc | 7.3b | 7.7ab | 7.1ab | 8.1ab | 7.6ab | 5.5b |
| Verti-Drain + Core Aeration | Apr. 1X + Jun 1X | Jul 1X + Aug 1X | Yes | 7.1abc | 6.3d | 7.6b | 7.5a | 8.0ab | 7.6ab | 7.8ab |
| Verti-Drain + Core Aertaion | Apr. 2X + Jun 1X | Jul 2X + Aug 1X | Yes | 7.1abc | 6.3d | 7.6b | 7.4a | 8.2a | 7.6ab | 5.5b |
| LSD (.05)[a] = | | | | .52 | .43** | .32** | .62** | .40** | .30 | 7.2 |
| CV (%) = | | | | 5.0 | 4.3 | 2.9 | 6.0 | 6.0 | 2.7 | 5.3 |

[a]**Significantly different F-test at 1% level.

[b]1X = one pass over the plot; 2X = two passes over the plot area.

Table 2. Turfgrass shoot density as influenced by cultivation treatment in 1991.

| Treatment Description | | | | Shoot Density | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 24 | 16 | 19 | 8 | 29 | 12 |
| Device | Application | | Compaction | May | Jun | Jul | Aug | Aug | Sep |
| | | | | 9 = ideal shoot density; 1 = no live turf | | | | | |
| Control | - | - | No | 8.2ab | 7.5bcd | 7.6c | 7.6ab | 7.8d | 7.6c |
| Control | - | - | Yes | 8.4a | 7.7bc | 7.7bc | 7.6ab | 8.0cd | 7.7abc |
| Turf Cond. | Apr. 1X | Jul 1X | Yes | 7.9b | 7.5bcd | 7.6c | 7.3c | 7.9cd | 7.8abc |
| Turf Cond. + Gypsum | Apr. 1X | Jul 1X | Yes | 8.4a | 8.3a | 8.3a | 7.8a | 8.4a | 7.9ab |
| Turf Cond. + Lime | Apr. 1X | Jul 1X | Yes | 8.1ab | 7.7bc | 7.9bc | 7.3c | 7.9cd | 7.7abc |
| Verti-Drain | Apr. 1X | Jul 1X | Yes | 8.1ab | 7.6bc | 7.8bc | 7.8a | 8.3ab | 7.9ab |
| Verti-Drain | Apr. 2X | Jul 2X | Yes | 8.5a | 7.9b | 7.9b | 7.5bc | 8.3ab | 8.0a |
| Verti-Drain + Core Aeration | Apr. 1X + Jun 1X | Jul 1X + Aug 1X | Yes | 8.3ab | 7.3cd | 7.8bc | 7.8a | 8.1bcd | 7.8abc |
| Verti-Drain + Core Aeration | Apr. 2X + Jun 1X | Jul 2X + Aug 1X | Yes | 8.2ab | 7.2d | 7.8bc | 7.7a | 8.2abc | 7.7abc |
| LSD (.05)[a] = | | | | .47 | .47** | .29** | .30** | .33** | .29 |
| CV (%) = | | | | 3.9 | 4.2 | 2.6 | 2.7 | 2.8 | 2.4 |

[a]**Significantly different F-test at 1% level.

Table 3. Relative clipping yield as affected by cultivation treatment in 1991.

| Treatment Description | | | Relative Clipping Yield | | | |
|---|---|---|---|---|---|---|
| | | | 7 | 19 | 30 | 23 |
| Device | Application | Compaction | Jun | Jul | Aug | Sep |
| | | | % | | | |
| Control | - | No | 138a | 104a | 114bc | 106abc |
| Control | - | Yes | 100ab | 100c | 100cd | 100abc |
| Turf Cond. | Apr. 1X | Jul 1X | Yes | 80b | 86a | 103cd | 105abc |
| Turf Conf. + Gypsum | Apr. 1X | Jul 1X | Yes | 94ab | 96a | 167a | 110abc |
| Turf Cond. + Lime | Apr. 1X | Jul 1X | Yes | 105ab | 99a | 113c | 105abc |
| Verti-Drain | Apr. 1X | Jul 1X | Yes | 72b | 88a | 144ab | 115ab |
| Verti-Drain | Apr. 2X | Jul 2X | Yes | 88b | 95a | 117bc | 132a |
| Verti-Drain + Core Aeration | Apr. 1X + Jun 1X | Jul 1X + Aug 1X | Yes | 104ab | 86a | 78d | 79c |
| Verti-Drain + Core Aeration | Apr. 2X + Jun 1X | Jul 2X + Aug 1X | Yes | 82b | 84a | 104cd | 94bc |
| LSD (.05) = | | | | 46 | 24 | 32** | 33 |
| CV (%) = | | | | 33 | 17 | 19 | 22 |

**Significantly different F-test at 1% level.

Table 4. Turf color as affected by cultivation treatment in 1991.

| Treatment Description | | | | Turf Color | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Device | Application | | Compaction | 24 May | 16 Jun | 19 Jul | 8 Aug | 29 Aug | 12 Sep |
| | | | | 9 = dark green; 1 = no green | | | | | |
| Control | - | - | No | 7.4b | 6.9de | 7.5c | 7.4b | 8.1ab | 7.5ab |
| Control | - | - | Yes | 7.6b | 7.4bcd | 7.8bc | 7.6b | 7.9b | 7.5ab |
| Turf Cond. | Apr. 1X | Jul 1X | Yes | 7.5b | 7.1bcde | 7.6bc | 7.6b | 7.9ab | 7.6ab |
| Turf Cond. + Gypsum | Apr. 1X | Jul 1X | Yes | 7.9a | 8.5a | 8.2a | 8.3a | 8.0ab | 7.5ab |
| Turf Cond. + Lime | Apr. 1X | Jul 1X | Yes | 7.5b | 7.3bcd | 7.7bc | 7.5b | 7.8b | 7.4b |
| Verti-Drain | Apr. 1X | Jul 1X | Yes | 7.6b | 7.4bc | 7.9b | 7.7b | 8.1ab | 7.6ab |
| Verti-Drain | Apr. 2X | Jul 2X | Yes | 7.5b | 7.5b | 7.7bc | 7.5b | 8.2a | 7.6ab |
| Verti-Drain + Core Aeration | Apr. 1X + Jun 1X | Jul 1X + Aug 1X | Yes | 7.5b | 6.8e | 7.8bc | 7.7b | 8.1ab | 7.6ab |
| Verti-Drain + Core Aeration | Apr. 2X + Jun 1X | Jul 2X + Aug 1X | Yes | 7.6b | 7.0cde | 7.8bc | 7.7b | 8.2a | 7.7a |
| LSD (.05)[a] = | | | | .22** | .44** | .29** | .35** | .28† | .27 |
| CV (%) = | | | | 2.0 | 4.2 | 2.5 | 3.1 | 2.4 | 2.5 |

[a]**,†Significantly different F-test at 1 and 10%, respectively.

Table 5. Saturated hydraulic conductivity as affected by cultivation treatment in 1991.

| Treatment Description | | | | Saturated hydraulic conductivity |
|---|---|---|---|---|
| Device | Application | | Compaction | 8 Aug |
| | | | | – mm $hr^{-1}$ |
| Control | - | - | No | 19.8bc |
| Control | - | - | Yes | 17.9bc |
| Turf Cond. | Apr. 1X | Jul 1X | Yes | 11.0c |
| Turf Cond. + Gypsum | Apr. 1X | Jul 1X | Yes | 23.4bc |
| Turf Cond. + Lime | Apr. 1X | Jul 1X | Yes | 20.0bc |
| Verti-Drain | Apr. 1X | Jul 1X | Yes | 23.8bc |
| Verti-Drain | Apr. 2X | Jul 2X | Yes | 41.3ab |
| Verti-Drain + Core Aeration | Apr. 1X + Jun 1X | Jul 1X + Aug 1X | Yes | 56.5a |
| Verti-Drain + Core Aeration | Apr. 2X + Jun 1X | Jul 2X + Aug 1X | Yes | 37.2abc |
| LSD (.05)[a] = | | | | 30.0[†] |
| CV (%) = | | | | 74 |

[a]Significantly different F-test at 10% level.