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# PREFACE

These Proceedings of the 32nd Annual Texas Turfgrass Conference are provided to those who registered at the Conference as a reference to the wealth of information presented during the program. Since it was not possible for you to attend all of the sessions, the Proceedings will give you an opportunity to gain additional information. Also, you may want to review the papers of the sessions you attended to pick up points you might have missed.

These Proceedings could not be produced without the dedicated effort of those making the presentations. We are indebted to each of the authors for their contribution to the Texas Turfgrass Conference.

Special appreciation is extended to Jake Loden, my secretary, for her assistance with the preparation of these Proceedings.

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# SAND FOR TOPDRESSING

by

Bill Davis*

Excellent putting greens don't just happen. They are the end product of a professional turfgrass manager. Each of us has played on greens which, at the time, were near perfect. Some were constructed of pure sand, some of pure clay. Some were solid stands of Penncross or Seaside, others pure Poa. Some are aerated frequently, some only once a year. Some are played every day, while others are open less than 6 months a year. Some are used by few players each day, while others commonly support more than 200 golfers daily. Because of this great variation in use, existing conditions, and micro and macro climates, the answer to excellent greens has to be the professional superintendent. He must be a problem solver and not just a schedule maker and ramrod of a maintenance crew. It is to the professional and to those working toward that goal that I wish to direct my thoughts and information on topdressing as a key management program to excellent putting golf greens. I have no cookbook formula to give anyone which will guarantee success, but better greens are possible if you can put the pieces together.

There is nothing really new about the concept of topdressing. Since the beginning of golf course management, it has been a natural and/or common practice. Unquestionably, topdressing is a necessary practice to improve the trueness of a putting surface. It also seems to invigorate and improve the growing condition of grass. In part, this may be due to the fertilizer and/or aeration which usually accompany topdressing. For many years the standard practice has been to aerate and topdress twice a year. Some courses still follow this practice. Others may aerate six times per year, but few courses have used light frequent topdressing as a major component of their putting green management program.

Several factors led us into the study of topdressing as a major management program for achieving high quality putting surfaces:

1. We learned through previous research and field experience that a medium-fine narrow partical size range of sand made an excellent growing medium.
2. These types of sands were relatively high rates.
3. They produced a stable firm surface.

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4. They accepted water at relatively high rates.
5. They retained moisture in the root zone as well as most mixes presently used for golf greens.
6. Their nutritional problems were no more difficult to solve than those of the various soils and mixes commonly used.
7. With the right sand, we had a medium which was easy to apply and work into the surface of growing grass.
8. Because our putting green grasses produced more organic matter than we need, there was no need to amend these sands to make a topdressing mix.

One major problem with any new program is how to get it accepted if it is likely to increase labor and material costs. To avoid this problem, we decided to eliminate aerating and verticutting from our basic experiments so that the total time expended on green management would remain about the same. We also decided to premix fungicides, herbicides, fertilizer and bentgrass seed into our topdressing sand. Our green management practices for greens, therefore would, consist of mowing, irrigating and topdressing. It worked for us, but, from a practical field operation, the premix of chemical and fertilizer posed many problems. Added chemicals and fertilizer were not always needed. During periods of very little growth, fertilizer was needed, but the addition of sand was not. Once herbicides and fungicides were added to a sand, the topdressing material had to be handled, stored, or disposed of under EPA regulations.

Our basic experiments were done on our campus experimental green. We also experimented on various practice greens using pure sand at different frequencies and amounts coupled with aerating frequency. We published the results from these experiments under the title "An Alternative Method of Greens Management." Since then, we have continued to field-test the program and work with superintendents to solve their problems in making frequent light topdressing a viable management program.

A key question to be answered in our research was whether frequent topdressing could be an effective method for controlling accumulation of thatch. Would it not enable us to get away from the problem caused by buried thatch layers which impede water movement and restrict depth of rooting? Would it not create a uniform growing medium and aid in the breakdown of this organic matter? We need a vigorous renewing turf to have a putting surface. On many greens, vigorous turf also produces excess thatch which gives an untrue surface, increases disease potential, and reduces the fastness of the green. Frequent light topdressing could, therefore, solve many of our problems in maintaining a high quality putting surface.

Experimentally we proved what we believed to be true, but the real value of any experimental work is its application to the field. Therefore, let us look at a range of questions and their possible answers:

1. Q. Will just any sand or topdressing mix give basically the same results?

A. No, for several reasons. Coarse sand particles do not work into the surface grass readily. Golfers do not like to putt on greens which have just been topdressed. Coarse sharp sands dull mowers and are abrasive to the grass. Sands which are too fine can seal the surface of a green and reduce infiltration.

2. Q. What type of sands do you recommend?

A. A relatively fine narrow range of particle size. Round sand particles are best. Table 1 gives the particle ranges we presently suggest for construction and topdressing. Table 2 shows several sands now used by some California golf courses.

3. Q. Are suitable sands readily available?

A. Yes and No. For the past 10 years we have tested sands from many areas of our state as a service to golf course superintendents. We find them in coastal deposits and dredge them from the San Francisco Bay. Some come from deposits on individual golf courses, and some come from many and varied river deposits. The nearest local sand and gravel company has been of little help. They produce concrete and plaster sands which may be washed but are too coarse. They basically are producing sands with a wide range of particle sizes so that when a little clay (cement) is added they produce an impermeable dence medium. Some sand companies now produce what we want because we have specified the grade of sand we desire and will no longer buy their standard grades. Most major sand suppliers can screen and wash to a specific grade range if you create the demand and will not except second best.

4. Q. Do you mix any amendments with the sand?

A. No. Amendments must be uniformly and evenly mixed if they are to measure up to their potential, and this greatly increases the cost of the topdressing medium. Topdressing is difficult to apply when moist. When dry, mixes separate. Typical sand and organic mixes become thin layers of organic matter and sand by the time they are brushed into the turf surface, and irrigation further separates them. Very fine organic matters can seal the surface, and coarse organic matter does not readily work down into the grass. Most greens already are producing more organic matter than we want, so why should we add more?

5. Q. How frequently do I need to topdress to achieve the maximum benefits of this type of topdressing program?

A. How fast is your grass growing? It is very likely that 20 applications a year (year-around play) would be too many. Fifteen applications was just about right for our Penncross green. At some periods of the year, topdressing every 2 weeks is just right, but you may well go for 8 weeks between some applications.

6. Q. Can I apply topdressing too frequently?

A. Yes. It is important to maintain some organic cushion. Excessive

turf damage can result from ball marks where sand is applied too frequently and/or too heavily.

7. Q. How much sand should I apply at each topdressing?

A. Assuming your only objective is topdressing and not quick buildup of a new surface, you should be applying 1/32 to a maximum of 1/16 inch.

8. Q. How do I apply such small amounts?

A. It takes good equipment and a skilled operator. Topdressing machines set at almost closed application settings have done a good job. Some superintendents have found broadcast fertilizer equipment to be the answer.

9. Q. Can these uniform medium fine sands be applied at the higher rates typically used when aerating and topdressing once or twice a year?

A. No. These finer sands are not as easy to move and push around over the green. If heavy amounts are desired for some specific reason, it would be best to make several uniform fine applications.

10. Q. Do you tend to build up the depth of the green much faster than typical aerating and topdressing practices?

A. Very little difference. At the frequencies which produced our best putting surface, the difference was less than 1/4 of an inch per year, when compared to standard practice. On golf courses, we have not seen an observable difference.

11. Q. Do you recommend limiting aeration and verticutting all together once you start a topdressing program?

A. No. The condition of your present green will, in part, govern how fast topdressing can become a major management program. It is best to increase your aeration at first in order to insure a good transition between your old and new surface. Some courses have found that a double aeration and/or deep aeration work best for them. During the first year, some courses have gone from two basic aerations to a maximum of six. Five-eighths-inch tines are used to start, then only 1/2- or 1/4-inch tines. Their topdressing might be much heavier at first, but they are soon on the 1/32- to 1/16-inch application rates. Verticutting may or may not be used, but with present day equipment many superintendents have found it beneficial.

12. Q. Once on the program, is aerating completely eliminated?

A. No. But we no longer use aeration as our basic and most effective means of relieving compaction and removing thatch. Once we have a new uniform surface with a depth of 2 to 3 inches, late spring and/or early summer aeration may be in order. Even though we do not have a buried thatch layer, we may want to reduce the density or firmness of the surface. Verticutting the plugs on the green will separate the sand from the organic matter. By removing the organic matter and brushing the

sand into the green, you will have topdressed without the need for adding extra sand. Some superintendents feel that of their 12 to 18 topdressings per year, 2 or 3 of them would be verticutting their aeration plugs.

13. Q. If you aerate, aren't you opening up the green for greater Poa annua invasion?

A. Yes and No. It depends on the time of year. We recommend only aeration in the late spring and early summer when Poa annua germination is at a minimum.

14. Q. How long before a topdressing program will make a major difference in the surface of the green?

A. This again depends on the condition of your green when you start the program and how soon you are developing a uniform surface. Considerable improvement has been noticed in greens before the end of the first year. More typically it takes about 18 months.

15. Q. Will your golfing membership like the new green surface?

A. Maybe yes - maybe no. If your golfers want a true firm green, the answer will be yes. If they expect a poor shot or an improperly played shot to stick on the green, they will be unhappy. Some players will have to take a few golf lessons and learn how the game is played.

16. Q. Can this program be easily incorporated into my present management program?

A. Yes. But it is a poor practice to go into any new program without first testing it out on your practice green. Your sand source is critical. Do you need new storage bins for you sand? Do you need to relocate or add sand storage bins in order to reduce the time it takes to move sand to your greens? Is your present topdressing equipment in excellent condition and will it apply evenly the right amount of sand? Does your crew know what is expected from the program and what it must do to make it work?

No doubt, there are many other questions we might ask and answer. In this paper, they should be unnecessary because this program is not for the nonprofessional superintendent. The true professional can make it work and results will be quite predictable. Tournament golf every day is possible. Less reliance on fungicides and herbicides is possible. You also may find that height of cut might well be increased and frequency of mowing reduced. If the primary function of your putting green is for putting and not just for a lush green carpet appearance, a properly developed topdressing frequency program could be the answer to great golf for your golfers and fewer problems for you.

TABLE 1: Suggested Particle Size Ranges for Sand Used in Golf Green Construction and Topdressing

| SIEVE OPENING mm | U.S. STANDARD SIEVE NO. | U.S.D.A. CLASS | CONSTRUCTION DESIRED | CONSTRUCTION ACCEPTED | CONSTRUCTION DESIRED | CONSTRUCTION ACCEPTED |
|---|---|---|---|---|---|---|
| 2.38 | 8 | FINE GRAVEL | | | | |
| 2.00 | 10 | | | | | |
| 1.68 | 12 | VERY COARSE SAND | | 0-10% | | |
| 1.41 | 14 | | | | | |
| 1.19 | 16 | | | | | |
| 1.00 | 18 | | | | | |
| .841 | 20 | COARSE SAND | 0-15% | 80-90% | | 0-15% |
| .707 | 25 | | | | | |
| .595 | 30 | | | | | |
| .500 | 35 | | | | | |
| .420 | 40 | MEDIUM* SAND | 80-95% | | 100% | 75+% |
| .354 | 45 | | | | | |
| .297 | 50 | | | | | |
| .250 | 60 | | | | | |
| .210 | 70 | FINE SAND | | | | |
| .177 | 80 | | | | | |
| .149 | 100 | | | | | |
| .125 | 120 | | | | | |
| .105 | 140 | | | | | |
| .088 | 170 | VERY FINE SAND | 4-8% | 5-10% | | 0-8% |
| .074 | 200 | | | | | |
| .063 | 230 | | | | | |
| .053 | 270 | | | | | |
| .044 | 325 | | | | | |
| .037 | 400 | SILT & CLAY | | | | |

The proportions proposed are tentative guidelines only. Individual sands should be considered in terms of infiltration rate when compacted and the moisture release curve. These will be affected by the particle size distribution within the limits proposed. The shape of the sand particles also must be considered, as round sand particles do not compact as readily as sharp sand particles.

*The key fraction is the medium sand. It should be the dominant fraction.

TABLE 2: Particle Size Distribution of Some Recommended Sands Being Used on Northern California Golf Courses

| Source | Fine Gravel | Very Coarse Sand | Coarse Sand | Medium Sand | Fine Sand | Very Fine Sand | Silt | Clay | Center* Three Fractions |
|---|---|---|---|---|---|---|---|---|---|
| Dillon Beach | 0.0 | 0.3 | 2.3 | 68.3 | 24.6 | 0.9 | 0.8 | 2.8 | 95.2 |
| Antioch Fill | 0.0 | 0.1 | 1.0 | 71.6 | 21.7 | 1.2 | 1.6 | 2.8 | 93.3 |
| Guadalupe | 0.0 | 0.0 | 0.9 | 76.6 | 17.9 | 0.2 | 0.0 | 4.4 | 95.4 |
| Brown Manteca | 0.3 | 4.1 | 28.5 | 42.9 | 22.3 | 1.4 | 0.2 | 0.4 | 93.7 |
| Santa Cruz 1070 | 0.0 | 0.0 | 11.3 | 62.5 | 23.2 | 1.0 | 1.5 | 0.5 | 97.0 |
| Coloma Sand | 0.9 | 0.3 | 17.5 | 52.9 | 23.0 | 0.8 | 1.3 | 2.0 | 93.4 |
| Lappis #10 | 0.0 | 0.0 | 19.2 | 75.3 | 4.1 | 0.0 | 0.7 | 0.7 | 98.3 |

*Note that the center three fractions of each of these sands is greater than 90% retained and that the dominant fraction is medium (0.50 mm to 0.25 mm).

# CORRECTING SOIL COMPACTION PROBLEMS RESULTING FROM INTENSE TRAFFIC

by

Dr. James B. Beard*

Soil compaction commonly occurs on intensively trafficked areas such as recreational and sports turfs. It is usually most serious on poorly drained, fine textured (clay) soils and is concentrated in the surface 2 to 3 inches. The result is increased soil density, reduced pore space, and a lack of soil aeration. Consequently, the root system is restricted and the overall health of the turf reduced.

Cultivation can be utilized to alleviate soil physical problems associated with compaction. Cultivation involves mechanical methods of selectively tilling established turfs without destroying the sod characteristics. It can be used to correct an existing problem or to prevent the development of impending problems.

## Assessing the Need for Cultivation

There are two primary indicators of a soil compaction problem. First, the soil surface feels "hard" when walking over the turf. There is a distinct lack of resiliency. In addition, difficulties are encountered when attempting to push a soil probe into the soil. The second indicator is a decreased rate of water penetration into the soil. The rate of water infiltration is reduced and surface runoff increased. Secondary indicators of a soil compaction problem include (1) reduced rooting depth and extent, (2) increased wilting tendency, (3) reduced shoot growth, and (4) reduced shoot density. When evaluating these indicators, comparisons should be made with adjacent but comparable turfgrass areas that have not received intense traffic.

## Effects of Cultivation

The positive and negative aspects of turfgrass cultivation are summarized in Table 1. The primary effects of turfgrass cultivation are

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on the soil characteristics which in turn provide a better environment for turfgrass growth. Any disruptive practice such as cultivation also has associated negative characteristics. However, the potentially serious effects of soil compaction on turfs are much more significant, thus necessitating cultivation even though certain problems may be associated with this practice. These negative characteristics should be recognized so that adjustments can be made in the (a) conditions under which cultivation is accomplished and (b) timing so that potentially negative effects are minimized.

Table 1. Effects of soil cultivation on soil physical properties and turfgrass characteristics.

| Positive | Negative |
|---|---|
| A. Soil: | A. Soil: |
| 1. Improved infiltration. | 1. Compaction zone may be lowered to just below the deepest cultivation. |
| 2. Reduced water loss by surface runoff. | 2. May disrupt a protective surface layer of a pre-emergence herbicide. |
| 3. Improved percolation of soil water. | 3. Increased soil water loss by evaporation. |
| 4. Improved aeration. | 4. Soil opening serve as soil burrows for insect pests. |
| 5. Less toxic gas accumulation. | |
| 6. Better resiliency. | |
| 7. Deeper penetration of immobile phosphorus and liming materials. | |
| B. Turf: | B. Turf: |
| 8. Deeper, more extensive rooting. | 5. Openings offer potential sites for weed invasion. |
| 9. Reduced wilting tendency. | 6. Disrupts surface uniformity. |
| 10. Improved shoot growth. | 7. May interfere with use or play. |
| 11. Improved turfgrass density. | |

## When to Cultivate

The degree of soil compaction that has occurred dictates, to a great extent, when cultivation should be considered. Whenever possible, certain additional criteria should be taken into account. First, three weeks of favorable growing conditions are desired for recuperation following extensive

cultivation. Cultivation should be minimized during periods of severe heat and drought stress or when turfs are being adversely affected by turfgrass pests such as insects, diseases, and nematodes. It is preferable to avoid cultivation during periods which are optimum for weed seed germination and weed invasion. For example, fall cultivation favors annual bluegrass invasion.

Criteria in addition to seasonal considerations include (1) deep, extensive root development so that the turf is not lifted during cultivation and (2) a moist but not excessively wet soil in order to ensure the deepest possible soil cultivation without excessive compaction.

Spring, early summer, and early fall are the periods when turfgrass cultivation is most commonly practiced. Cool season turfgrasses may be cultivated in either the spring or fall, while warm season species are most commonly cultivated during the late spring-early summer period.

## Types of Coring

There are six basic types of cultivation with numerous variations from these types. Each has certain advantages and disadvantages. The decision as to which type to use depends on the (a) depth of cultivation desired, (b) degree of disruption that can be tolerated, and (c) time required to cultivate a given turfgrass area. A summary comparison of the six basic types of turfgrass cultivation is given in Table 2.

Coring: Involves the use of hollow tines or spoons to create holes by the removal of soil cores. Tine sizes available include 1/4, 3/8, 1/2, 5/8, and 3/4 inch. The basic types of coring are:

(a) Vertical-action hollow tines. Two to four hollow tines are commonly mounted on each vertical shaft which operates in an up and down motion. The unit may consist of from 4 to 6 vertical shafts.

(b) Circular-action hollow spoons. Semi-open spoons are mounted on a reel that has a circular, fracturing action. A number of different spoon designs are available.

Slicing: Involves a deep vertical cutting action that provides soil openings and loosening. The slicing unit normally is constructed of V-shaped knives mounted on independently suspended, weighted wheels.

Forking: Involves a solid tine that punches small holes in the soil. It can be achieved with tines mounted on a drum that operates in a circular motion or manually using a 4- to 5-tined fork.

Shattering: Involves vibrating mole blades that create a fracturing effect in the soil. This is a recent addition to the types of equipment available for turfgrass cultivation.

Spiking: Involves the shallow perforation of the soil surface by means of elongated toothed, circular blades. Both weighted power units and manually operated types are available.

Grooving: Involves mechanically powered, vertical knives or circular saw-toothed blades that cut vertical grooves or slits in the soil. The vertical rotating action may be in the opposite or same direction that the machine is mowing.

Table 2. Comparisons among the six basic types of turfgrass cultivations.

| Type of cultivation | Cultivation characteristics | | | | Widths available (inches) | Power Source | Comments |
|---|---|---|---|---|---|---|---|
| | Depth (inches) | Soil removed | Tine or blade spacing (inches) | Degree of fracturing of the adjacent soil | | | |
| Coring: | | | | | | | |
| Vertical tine | 3-4 | Yes | 2,4,6 | Minimum | 16,24 | SP | Many sizes and types of tines and spoons are available |
| Circular spoon | 4-6 | Yes | 4,5,6, 7,10,12 | Considerable | 16,24,36, 48,60,84, 72,96,252 | SP & T | |
| Slicing | 4-6 | No | 6,7 | Significant | 36,48,72, 84,96,252 | T | Many types of blades are available |
| Forking: | | | | | | | |
| Mechanical | 2-3 | No | 1,2,3 | Minimum + | 30,56,18, 24,48,64, 72 | SP & T | Not widely used in U.S. |
| Manual | 6-8 | No | 1,2,3 | Minimum + | 6,12,10, 14 | - - | |
| Shattering | 5-7 | No | 9 | Considerable +++ | 27 | SP | Blade has a bullet point |
| Spiking: | | | | | | | |
| Mechanical | 1-2 | No | 1,5,2 | Minimum | 25,28 | SP & T | Effective cultivation depth is limite |
| Manual | 0.5-1 | Yes | Variable option | Moderate ++++ | 6,8 | | |
| Grooving | 0-4 | Yes | Variable option | Moderate ++++ | 18,22, 24,48 | SP | Must have a good rooting depth |

*SP - self propelled

T - Towed by a powered vehicle

## Other Uses of Cultivation

Although the most common reason for cultivation involves a soil compaction problem, there are other turfgrass maintenance practices in which cultivation equipment can be utilized. Included is the stimulation of juvenile shoot and root growth from nodes immediately adjacent to severed stolon and rhizome internodes. This is the primary beneficial effect of spiking in many cases.

Cultivation is also utilized in enhancing thatch decomposition. This is particularly true for those types of cultivation in which a quantity of soil is brought to the surface where it acts as a topdressing.

Cultivation can be utilized as a soil tillage operation during the overseeding of turfs. More specifically, it provides improved seed-soil contact when renovating and overseeding existing turfs. When employed in conjunction with winter overseeding of dormant warm season turfgrasses the cultivation should be accomplished at least 30 days prior to the actual overseeding date.

Cultivation is also utilized as one method of soil physical improvement. Specifically, cultivation involving soil removal is utilized to break up soil layering problems caused by improper topdressing, wind deposition, or soil deposition following flooding. Special equipment has been designed which produces large, deep cores that can be filled with soil of a more desirable texture. In this respect deep cultivation is utilized as a method of partial soil modification.

## Summary

Turfgrass cultivation is a vital tool available for the maintenance of turfgrass areas, if properly utilized. It should be used judiciously as dictated by an existing or impending turfgrass soil compaction problem. Certain turfgrass areas, particularly those on well drained, coarse textured soils of limited traffic, may never require cultivation. However, on other areas, such as intensively trafficked sports and recreational turfs, cultivation is a necessity if a healthy turf of acceptable quality is to be maintained. In some cases it may even be necessary to cultivate as frequently as monthly.

# GRASS ROOTS - CULTURAL PRACTICES AFFECT ROOT GROWTH**

by

Richard L. Duble*

In an introduction to a classical article on root growth by Eliot Roberts and John Bredakis, Gene Nutter stated "As the roots go, so goes the grass." Research conducted since that article was published has generally supported that statement. Yet there are those who doubt the importance of a well developed root system to a high quality turf. In 1925, O. B. Fitts concluded a study on root growth in fine turfgrasses with the statement, "Treat the grass surface and forget all about root growth." Observation of the roots on a bentgrass golf green in the summer can raise some question as to the importance of a strong root system. Many beautiful bentgrass greens have a very weak root system in mid-summer.

Although there is some controversy as to the significance of roots to the quality of putting green turf, there can be little doubt as to the importance of roots to a healthy turf. Perhaps a closer look at the evidence will help you decide on the importance of grass roots in your operation and, also, help you manage the turf to promote a healthy root system.

## The Grass Root System

The main roots of grasses are produced at the nodes or crowns of tillers, stolons and rhizomes. They are white, small in diameter, fibrous and greatly branched. Roots produced in spring and fall are usually larger than those produced during the hot summer months. Each tiller or stolon of a grass plant is capable of producing its own root system and, to some extent, acts as an independent plant.

The main roots of grasses exhibit a high degree of branching, but considerable variation exists between species. Within a turf, competition between plants (tillers) reduced the amount of branching. The size and strength of roots decline progressively from the main roots to the lowest order of branches. The branch roots are composed of young, active tissue with a tremendous capacity to absorb water and nutrients. To a large extent, the ability of a grass (tiller) to compete and its value as a turfgrass depends on the degree of branching.

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The root hairs of grasses are almost microscopic in size, but contribute greatly to the absorptive potential of the root system. The root hairs of grasses are quite persistent and may be found over the entire length of the root. Root hair formation is largely influenced by environmental conditions and calcium availability.

To give some idea of the magnitude of the grass root system, a plug of Kentucky bluegrass 3 inches in diameter and 6 inches deep may have 85,000 roots with a combined length of 1250 feet. If root hairs are included, there would be over 50 million with a total length of 32 miles. Such a root system would have a surface area of 17 square feet. All of this is contained in a volume smaller than the standard hole on a golf green.

The depth to which grass roots penetrate increases rapidly during seedling growth or following transplanting sod. Shortly thereafter the rate of penetration decreases. The maximum depth of penetration is usually reached during the first year. Grass roots are not equally distributed throughout the whole depth of penetration, but are concentrated in the upper 6 inches of the soil profile. The actual distribution is, however, influenced by environmental and cultural factors as well as by grass species.

## Root Growth Patterns

From the time a seed, a rhizome or a tiller initiates a root, the root develops slowly at first, goes through a period of rapid growth, matures and then dies. The life span of turfgrass roots depend on grass species, time of year initiated and environmental conditions. The longevity of roots may vary from less than 6 months for some grasses to almost 2 years for others. Kentucky bluegrass and bermudagrass retain a major portion of a functioning root sytem for more than a year, and are *perennial rooting-type* grasses. In contrast, perennial ryegrass, fescue and bentgrass replace most of their root systems each year and are considered *annual in nature* with respect to roots.

Root death and replacement is a continuous process in some grasses, while in others it occurs at a specific time of the year. In cool season grasses, root death and deterioration is extensive during the mid-summer stress period, while root initiation is minimal during this time. Creeping bentgrass root initiation ceases at soil temperatures above $75^{o}$, and the maturation rate of existing roots increases. Root growth of warm season turfgrasses such as bermudagrass, St. Augustine and zoysia is most vigorous during the spring and summer, occurs to a lesser extent in the fall and ceases during the winter dormant period. Root growth does occur at temperatures below those at which shoot growth ceases.

As grass roots mature they change in color from white to brown, decrease in diameter and become less active in absorbing water and nutrients. Environmental stresses such as drought or heat, improper mowing or herbicides can produce the same changes in root appearance and activity.

The root system serves the plant by absorbing water and nutrients, but roots also provide storage sites for carbohydrates (energy reserves). Cool season grasses accumulate carbohydrates in the fall and spring. During the hot summer months or when vegetative growth is excessive, these stored carbohydrates are utilized by the plant for growth. They may also be utilized for regrowth under close defoliation or when the grass is recovering from injury (mowing, traffic, drought, insect or disease damage).

The roots of warm season grasses accumulate carbohydrates during the spring, summer and fall when conditions are favorable for growth. In both types of grasses these reserve carbohydrates help the turf tolerate environmental and cultural stresses.

## Mowing Affects Root Growth

The depth or rooting of cool season grasses is greatly reduced by mowing; whereas, root distribution of warm season turfgrasses is only slightly affected by mowing. Mowing height has a greater affect on root growth than mowing frequency. Kentucky bluegrass mowed at a 1/2 inch height had as much root activity in the surface 6 inches as that mowed a 1-1/2 inches. But, root activity in the 6 to 12 inch soil depth was severely restricted by close mowing. Mowing frequency, even at the shorter mowing heights, does not overcome the affect of mowing on root activity. In fact, root activity is reduced when turf is mowed more frequently. Juska and Hanson showed that roots increased from 12 per cent of the plant weight to 18 per cent when mowing frequency was reduced from 5 to 1 time per week at a height of 1 inch. Madison demonstrated a similar response to mowing frequency with Highland bentgrass. Both workers showed a reduction in turf vigor corresponding to the reduction in root growth. Frequent defoliation was also found to deplete carbohydrate reserves in the root system.

Warm season turfgrasses respond quite differently to mowing. Bermudagrass mowed 3 times per week at a height of 1/2 inch maintained as much root growth as that mowed weekly at 1-1/2 inches. The low, frequent mowing schedule in this study was maintained for a 2-year period. In addition to maintaining the same level of root production, the carbohydrate reserves in the root system were the same for the low, frequent mowing schedule as for the higher and less frequent mowing schedules.

The ability of bermudagrass to maintain a vigorous root system under close and frequent mowing is to a large extent due to its prostrate growth habit. Even with close, frequent mowing an adequate portion of green foliage remains to prevent a depletion of carbohydrate reserves. Creeping bentgrass, which also has a prostrate growth habit, shows a similar response to mowing. Madison demonstrated that the root system of creeping bentgrass is not adversely affected by close mowing.

Support for the hypothesis that the prostrate growth habit of these grasses accounts for their resistance to close mowing was obtained by complete defoliation of turfs for a sustained period. When bermudagrass turfs were completely defoliated at weekly intervals for 6 months, 97 per cent of the carbohydrate reserves in the root system were depleted. Whereas with normal close mowing carbohydrates actually accumulated. Apparently, with both bermudagrass and bentgrass sufficient green foliage remains after mowing to maintain photosynthetic activity and prevent carbohydrate depletion.

## Nitrogen Affects Root Growth

As with mowing, the affects of N on root development are quite different between warm season and cool season grasses. Generally, root development in Kentucky bluegrass, fescue and bent is decreased by increasing N rates. However, the timing of N applications greatly affects the response of roots. Fall and winter applications of N have been shown to increase root growth in these cool season turfgrasses; whereas, spring and summer applications of N reduce root growth. This interaction of N with season can be attributed to the growth pattern of the grasses. Applications of N in the fall and winter, when temperatures do not favor top growth, promote carbohydrate accumulation. Since the roots grow at lower temperatures than shoots, the carbohydrates are utilized for root growth. Spring applications of N, when temperatures favor shoot growth, stimulate the utilization of carbohydrate reserves for shoot production. Frequent removal of leaves by mowing further stimulates the utilization of carbohydrate reserves for regrowth. Since the shoots have priority over the roots for carbohydrate reserves, the root system is the first to suffer.

Fall and winter applications of N to bluegrass or bentgrass turf does not eliminate the need for N at other periods of the year. Low rates of N that do not stimulate excess top growth can be made in the spring without reducing the root system. Also, Snyder and Schmidt demonstrated that the application of iron with N in the fall, winter and spring increased bentgrass turf quality without decreasing root growth.

In contrast to the cool season grasses, the roots of warm season grasses increase in weight and depth with increasing N applications. However, just as with cool season grasses the root-top ratio of warm season grasses is greatly reduced by N applications; not because of reduced root growth, but because of increased top growth.

## Aeration Essential for Root Growth

Compacted soils and poorly drained sites restrict the movement of oxygen into the soil and of carbon dioxide out of the soil. Both of these conditions are highly unfavorable for the growth of grass roots. Letey demonstrated the importance of soil oxygen to the growth of Kentucky

bluegrass roots. When oxygen was restricted to the rootzone, root growth was minimal. When oxygen was provided to the rootzone, roots penetrated to a depth of 18 inches. Bluegrass mowed at a 1-inch height required 5 per cent oxygen in the rootzone for maximum root growth, while that mowed at 2 inches required only 2 per cent oxygen.

Perhaps more important than oxygen concentration is the rate of movement of oxygen into the rootzone, the oxygen diffusion rate (O.D.R.). Turf areas that receive heavy traffic are subject to surface compaction, a condition that greatly decreases the O.D.R. of the soil. Letey measured the O.D.R.'s. They also reported that turf quality and O.D.R. of golf greens could be significantly increased by mechanical aeration and top-dressing. Turf quality and O.D.R. of golf greens could be significantly increased by mechanical aeration and topdressing.

Waddington and Baker found that bentgrass and goosegrass were much more tolerant to poor aeration than was bluegrass. While the depth of rooting of bluegrass was greatly reduced under conditions of low oxygen supply, bentgrass root weight was only slightly affected. Roots produced under low oxygen conditions were much thicker and had fewer lateral branches.

Working with common bermudagrass, Letey showed a definite improvement in the depth of rooting with increased soil aeration. They found that amendments such as peat, redwood bark and calcined clay improved aeration of compacted soils and increased rooting depth of bermudagrass.

## Frequent Irrigation Produces Shallow-Rooted Turf

Irrigation practices that maintain moisture only in the surface few inches of soil produce shallow-rooted grass. Madison demonstrated that daily irrigation decreased root growth and was, in fact, deleterious to bentgrass turf. The combination of frequent irrigation, close mowing and high fertility further reduced root growth. This combination utilizes reserve carbohydrates for regrowth at the expense of the root system. Less frequent irrigation favored carbohydrate accumulation and root growth.

Irrigation schedules should provide adequate water at a single setting to maintain a turf for several days. Such an irrigation schedule produces deeper rooted and more drought tolerant turf than that which is irrigated frequently.

However, some soils may require frequent irrigation to overcome environmental stresses for short periods of time. Coarse textured soils have a very low water holding capacity and may require frequent irrigation to maintain turf quality during dry months. But, even under those conditions, irrigations should be spaced as far apart as possible without seriously affecting turf quality.

## Herbicides Affect Root Depth

Preemerge herbicides such as calcium arsenate, bensulide, benefin, siduron, DCPA and others inhibit the roots of grasses to some extent. A healthy turf that is properly maintained may not show any damage from these herbicides. But, the same treatment may severely damage a turf under stress conditions such as drought, temperature extremes or traffic. The rate of recovery of turf from injury may also be decreased because of a stunted root system caused by some preemergence herbicides.

## Manage Turf to Promote Root Growth

Whether you are concerned with lawns, golf courses, athletic fields or sod production, the development of a vigorous turf requires a strong root system. Without question a high quality turf can be maintained where the root system is weak; but, the intensity of maintenance required is much greater.

Grass species, environmental and cultural practices interact to determine the extent of rooting for a particular turf. Cool season grasses should not be stimulated with nitrogen during late spring and summer. These grasses should be mowed as high and as infrequently as practical for a particular use.

Warm season turfgrasses can be fertilized throughout the growing season without reducing root growth. These grasses can also be mowed closer than most cool season grasses without affecting root growth.

Root growth of all turfgrasses responds to aeration where oxygen is restricted to the rootzone by compaction, poor drainage or excessive thatch. Likewise, irrigation practices that provide water on a thorough and infrequent basis promotes deep rooting of turfgrasses.

The statement by O. B. Fitts, "Treat the grass surface, and forget about the roots," does not apply today any more than it did 50 years ago. It is possible to produce a high quality turf without seriously retarding root growth.

# CULTIVATION PRACTICES FOR TURFGRASS

by

J. R. Watson*

Turfgrass is one of the few permanent crops grown by man. Most all other crops are periodically harvested or rotated and the soil tilled or cultivated. Permanent pastures which have basically the same cultural requirements as turfgrass and which develop, with age, some of the same basic problems are periodically subjected to conventional cultivation -- discing, plowing or harrowing. These practices are most beneficial and do not disrupt grazing. When turfgrass areas develop conditions requiring cultivation; or, when cultivation becomes necessary to prevent or avoid (as opposed to correct) a deleterious soil condition, one of the major considerations becomes, how to do the job with minimal disturbance of the surface. Too, cultivation must be accomplished in as short a period of time as possible. To accomplish these objectives specialized tools have been developed and many of these have undergone modification during the past 20 to 25 years. Today the green industry has available tools that will cultivate turfgrass areas quite satisfactorily, and, for the most part, in a manner acceptable to those who use the facility.

Why cultivate. Turfgrass areas are cultivated for several reasons. Among them: (1) to alleviate soil compaction and thereby to improve water infiltration -- movement of water into the soil rather than have it run off or pond. (2) To promote exchange of soil and atmospheric gases-- oxygen into the soil, carbon dioxide and sometimes toxic gases like methane out of the soil. (3) To correct and to prevent thatched conditions -- accomplished by incorporation or mixing this organic accumulation into the soil. (4) To facilitate placement of fertilizer materials -- especially calcium (lime) and phosphorus -- in the rootzone rather than to leave them on the surface. These results of cultivation, individually and collectively, improve the rootzone environment and thereby encourage development of deeper and more extensive turfgrass roots. This in turn impacts or interacts with other cultural practices -- fertilization, watering, mowing and often pesticide control programs.

Definition. The subject of cultivation has appeared on turfgrass educational programs for many years and still remains a popular topic. Incidentally, many of the early programs listed the discussion under titles like aerifying, aeration, aerating and similar. And, while these words are not necessarily incorrect, they are not as descriptive or as all encompassing as the term "cultivation." Cultivation is preferred

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because it includes all the various mechanical devices and practices used to till turfgrass areas. Too, the results of these tilling operations, as partially enumerated earlier, are more extensive than just an impact on soil air. Discussions of cultivation practices and procedures from a basic as well as an applied approach are likely to continue wherever turf or green industry groups convene. And, the subject will continue to appear on conference programs. For, in spite of the present state of knowledge concerning this practice, it is not always easy to detect or to predict under field conditions those situations which will require cultivation. Unlike golf greens where such symptoms are more easily recognized, the turf on school grounds, parks and other general turf areas not only is cut higher but also the grounds are more extensive.

Soil Compaction. Turfgrass areas are subjected to varying degrees of traffic. And, on extensive areas, as well as, unfortunately, on many intensively used sites, soil physical properties -- texture, structure and porosity -- are highly variable. Further, when these soils are modified to improve physical properties, too often the amendments or the proportions are sub-optimized and the results are highly disappointing -- sometimes disastrous. Traffic, both foot -- player, user -- as well as vehicular causes the soil particles to be squeezed together. As this "squeezing" action continues, the soil becomes more dense. This compression or increase in density is at the expense of soil air. (As soil becomes more compact, there is an increase in micro-pores and a decrease in macro-pores.) Compaction occurs more rapidly on clay soil than on sand. And, since water acts as a lubricant, soils are more severely compacted when they are wet and subjected to traffic -- example, football fields when games are played in the rain.

The effect of soil compaction on turfgrasses is insidious -- proceeds inconspicuously and frequently unrecognized until stress conditions cause loss of turf. The turf manager must constantly be on the lookout for ecological changes in the sward, especially shallow rooted grasses and taprooted broadleaf weeds, for an apparent need to irrigate or fertilize on an increasingly frequent basis; and for lack of a favorable response to fertilizer, iron or other materials. Increased runoff or ponding of rainfall or irrigation water is often an indicator of potential trouble. Too often these subtle changes are the result of a decreasing air-oxygen supply in the soil with a subsequent, or for that matter, concurrent loss or substantial decrease in the root system.

Thatch. Cultivation plays a key role in the control and removal of thatch. However, since thatch and its associated problems are most critical on golf greens, a detailed discussion of the relationships between cultivation and thatch will not be covered in this paper.

Methods of Cultivation. Turfgrass areas are cultivated by tools or equipment which core, slice, groove or spike. Coring involves the use of a hollow tine or spoon that removes a plug or core of soil. These units are of varying diameter, 1/4 inch to usually 3/4 inch, and they are designed

to penetrate from 2 to 4 inches on spacings of 2 to 6 inches. Slicing is accomplished with a vertically cutting knife in the form of a disc or V-shaped blade. These are usually mounted on heavy wheels which are pulled across the turf. They slice to a depth of 3-4 inches on variable spacings. Grooving is a similar technique to slicing except this process is usually done with a rapidly revolving circular blade or disc. The soil is sliced (grooved) to a depth of 2-4 inches. Spiking is accomplished by use of the solid tine, knife or blade which is used to "punch a hole" through the grass (and thatch, if any) and into the soil. Depth is variable but rarely exceeds 2 to 3 inches.

Spiking is used most often on putting greens during periods of stress when the use of a coring device is risky. Grooving is useful in removing thatch. Caution must be used with this tool since shallow rooted turf can be easily damaged. Slicing is probably most practical for large turf areas like parks and school grounds and coring is most beneficial for athletic fields and other intensively used facilities.

When to Cultivate. Timing of cultivation is one of the more critical management decisions. Timing is basically a function of the rate of growth, or growth response, of the permanent turfgrass species and, to an extent, is a compromise between this and the germination period or optimum growth conditions of weeds. Timing of cultivation also is modified to tie in with fertilizer application and, in the case of non-irrigated facilities suffering from drought, in anticipation of rainfall.

The best time to cultivate is "when the permanent grass is growing most actively." And, since growth is primarily a function or response to temperature, this calls for cultivation during late spring, summer and early fall for warm season grasses -- bermuda, St. Augustine, Zoysia, Bahia -- and early spring and fall for cool season grasses -- bentgrass, bluegrass, ryegrass and fescue. If these times coincide with germination of weeds, as is often the case, the manager must decide on the best balance between the two events. Also, if weeds like crabgrass or Poa annua are a problem, development and implementation of either, or both, pre- and post-emergence control programs may be essential.

Cultivation during periods of slow growth or during dormancy sometimes become necessary -- either to improve water infiltration, to avoid runoff, to restore soil moisture, or to facilitate deep placement of fertilizer or all. The critical decision in such cases must be based on the balance between the benefits to be derived for the permanent grass versus the certainty of increased or more prolific growth of contra-seasonal weeds. The decision to cultivate, or not to cultivate, during optimum time periods for the existing permanent grass also may be influenced by long range plans for the site. For example, if a new improved cultivar or a new species or permanent grass is programmed.

Soil moisture conditions impact the timing of cultivation. Moist soils are essential for adequate penetration. On non-irrigated facilities, cultivation should be planned to coincide with rainfall.

Finally, cultivation of turfgrass must be coordinated with the use of the facility. This is, perhaps, more applicable to putting greens but must be considered when cultivating or planning for cultivation of football or other athletic fields. Many coaches object to coring of a field especially just prior to or during the playing season. Sometimes with justification, sometimes not. In those cases where coring is objectionable and cannot be used, then slicing should be considered. Most football fields require or at least need to be cultivated during the playing season. This is especially needed on those fields that are easily compacted (heavy or clay soil), where games are played in the rain and where ryegrass (or other cool season grasses) is introduced to maintain or to develop green grass for late or post season play. Timing of cultivation (slicing) must be keyed to the schedule of events as well as temperature.

## Summary

Cultivation is an essential management practice on most turfgrass facilities. Cultivation alleviates soil compaction, improves water infiltration, aids in deep placement of fertilizer materials and facilitates exchange of soil and atmospheric gases. These benefits result in a deeper, more extensive root system. Cultivation interacts favorably with other cultural techniques and for the most part produces beneficial effects; although certain negative or detrimental results are recognized. Timing of cultivation is critical. The impact of temperature and moisture on growth response of permanent grasses as well as weeds and coordination with scheduled events and long range plans are some of the factors that must be taken into account when programming cultivation of turfgrass facilities.

# GROUNDS MAINTENANCE EQUIPMENT, MAINTENANCE AND REPAIR

by

Jim Joplin

Good afternoon -

Well it looks like another good Texas Turfgrass Conference we've got going. I'd like to thank the association for asking me back again, and especially Fred Houston for the introduction and his interest. To be picked to speak on the same program with Jim Watson and Jim Lathem is an honor in itself. I can only hope when someone asks you how this session went, you will say "It was good, Jim made a good talk." Thats the only way I have a chance with these guys.

We could spend a couple of days, instead of 40 minutes, turning this talk into a greasy nuts and bolts show. So since no one likes to talk or hear about greasy nuts and bolts, I'm going to try to interest you in the philosophy, planning, preparation, and execution of a good maintenance program. And the best maintenance program is a preventive maintenance program.

I would like to give you, what our service department people feel, is the most important points in preventive maintenance.

## Preventive Maintenance

Preventive maintenance is the key to increased equipment life, to long and economical operation, and to insure user satisfaction.

Preventive maintenance is the link in the chain of success that begins with the manufacturer which you the user have direct control over.

As such, the area of preventive maintenance offers you the very real possibility of extending equipment life at an overall reduction in dollar spent for maintenance.

Obviously, if you as a manager of men, equipment and money are able to increase the overall efficiency of your operation, while reducing total expenditures, you are well on the way to being a success.

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In today's economy about the only thing that is remaining within reason, at least from your boss' point of view, is your budget.

Since labor cost, machine costs, repair parts cost and all other tangible expenses that you deal with on an everyday basis are going up, the real challenge of the future, will be to do a better job with what you have.

What you have is the ability to reduce in a dramatic and real way the large dollar outlays that have occurred due to equipment breakdown.

You are the man who can make this change.

I. Why Do You Need Preventive Maintenance?

To save money, to minimize downtime, and to extend the operational life of a piece of equipment.

Dollars savings realized by an effective preventive maintenance program are difficult to project so perhaps the best use is one of comparison. Compare your operation to another. Are you going from crisis to crisis while the other man mows smoothly through the cutting season? If so, the difference is probably in his maintenance program. Resolve to try his successful methods. You will be pleased with your results.

II. When Do You Start Preventive Maintenance?

Start now in this new year with a preventive maintenance program and look forward confidently to the coming turf care season ahead. Your program won't be perfect the first week, or even the first month, but with experience you will soon realize its benefits. Remember nothing succeeds like success. Once you establish a history of success you will find that continued success becomes routine.

III. How?

Use the resources you now have available. Fortunately preventive maintenance doesn't cost money. Your present facilities are adequate no matter how modest. Preventive maintenance is basically free because most of all, it takes only you to put it into practice, the knowledge that you have, that is contained in your reference material, and this is available to you free of charge.

Let's look at the dollar and cents of preventive maintenance using a seven gang fairway mower as an example.

The recommended daily hands on and visual inspection procedure will take a total of approximately 15 minutes. Checking for reel end play, real to bed knife adjustment, rollers, etc.

Your cutting season is about 8 months and you use the equipment 5 days per week or a total of 160 days.

You pay your mechanic $5.00 per hour.

160 days at 15 minutes per day is 2,400 minutes or 40 hours.

40 hours at $5.00 per hour is $200.00 total labor.

Without routine inspection and maintenance you could easily spend well over the amount in downtime, repair parts, labor, and aggravation.

You can even reduce that figure by training your operation to perform these simple procedures. Let's face it if you can use a lower paid man instead of your mechanic, do it.

IV. Where Do You Look for Maintenance Information?

Your owners and operators manual

The Engine manual

Trade publications

Fellow managers

Maintenance and lubrication charts

Maintenance and overhaul manuals

Factory service schools

Distributor service and sales personnel

More is probably written about preventative maintenance than any other maintenance related subjects, but the information is worthless unless it is used. The value to you is unlimited when you put it into practice.

V. The Meaning of Parts Replacement and Preventive Maintenance.

INSPECTION: Parts replacement preventive maintenance is a systematic series of inspections performed periodically in order to keep equipment operating at top efficiency. Bed knives and other normal wear parts for an example.

PURPOSE: The primary purpose of parts replacement and preventive maintenance is to prevent major breakdown and the consequent need for repairs.

FUNCTION: The primary function of periodic trouble shooting inspections of component parts is to locate and repair or replace existing wearing, missing or damaged parts.

IMPORTANCE: Parts replacement and preventive maintenance is of the upmost importance since the failure or inefficient operation of one piece of equipment may cause the failure of an entire turf care program, most often at a critical time.

RESPONSIBILITY: Parts inspection and replacement are the responsibility of the operator and maintenance personnel. Or is it? The ultimate responsibility is who's? You guessed it. The buck stops with you.

ON HAND PARTS STOCK: Order from your distributor and have on hand, for immediate repair, a spare parts stock for each unit to keep it operating with a minimum of downtime. It will help your ulcers.

TRAINING PERSONNEL: Operators of equipment must be thoroughly familiar with the equipment and with the manner in which the equipment is to be inspected and serviced. This is the weakest link. We can take a well designed, manufactured, and adjusted piece of equipment, give it to the lowest paid, least responsible, and most hurried man in your organization. He can tear it up in an hour.

## VI. Inspection

GENERAL: General inspection and service of a component part also applies to any supporting member, connection, or associated part, and usually consists of a check to see whether or not it is in good condition, correctly assembled, secure, or is excessively worn.

CORRECT ASSEMBLY: Inspection for correct assembly is usually a visual inspection to determine whether or not the item is in its normal position.

SECURITY: To check the item for security, use a screw driver, wrench, or pliers, or feel it by hand. Such an inspection should include all mountings, nuts, bolts, screws and other fastenings.

EXCESSIVE WEAR: Excessive wear means wear which is likely to result in failure of that part if it is not replaced before the next scheduled inspection.

## VII. Schedule of Inspection and Procedures

### BEFORE OPERATION

PURPOSE: Primarily as a check to see that the unit has not been damaged or tampered with since the last after-operation inspection was performed.

PROCEDURE: Generally check for fluid leaks, loose connections, brackets, or attachments, and operational adjustments.

DURING OPERATION

While the unit is in operation and delivering its normal load, listen for rattles, knocks, squeaks, or hums that may indicate trouble. Make certain that rattles are not covered by loose fastenings. Watch for smoke from any part of the unit. Be alert to detect overheated components, fuel vapor from a leak in fuel system, and exhaust gases or other disorders that may be an indication of trouble.

THE SHOP INSPECTION

The shop inspection may be regarded as minimum maintenance to effect temporary repair, to be corrected in after operation service.

AFTER OPERATION

PURPOSE: After operation inspection is particularly important. At that time the operator inspects the unit to detect deficiencies that have developed and corrects those he is aware of. If performed thoroughly, the unit should be ready to operate when needed. Never omit the after operation inspection.

PROCEDURE

Check for fluid leaks

Clean equipment

Check ignition, electrical wiring, battery, and other wiring for defects and dirty or loose connections.

Springs and suspensions

Lubrication

Air cleaner

WEEKLY MAINTENANCE INSPECTION

See that all inspections and maintenance series have been performed.

END OF SEASON INSPECTION

1. Determine whether a unit should be continued in service, overhauled, or salvaged.
2. Review the course of difficulties encountered in service resulting in wearing, missing or damaged parts.
3. Insure that all defects have been corrected before the unit is returned to use.

4. Replace all existing worn or damaged parts with genuine manufacturer's part.
5. Paint and refinish to prevent rust and corrosion.
6. Hold downtime to a minimum by keeping a stock of normal wearing parts on hand.

Preventive maintenance is your tool to being a successful and satisfied user.

I would like to add a few things and then I'll get off the soap box.

There is a lot you can do to help yourself alleviate maintenance and downtime problems, even before you start an equipment maintenance program.

1. Know the area to be maintained completely. Size, terrain, obsticles, and desired finished appearance are important.
2. Time allocated to maintain the area. A little larger piece or different type of equipment at a higher price that can be used 20 hours per week, is often more economical in the long run, than a lower priced piece of equipment that you may have to punish 40 hours a week to get the job done. There is a big difference between price and cost.
3. After weighing and studying the above, you can select the right equipment. Be sure to consider where you purchase the equipment. We are blessed in this area to have some of the best qualified distributors in the country. Their service, parts back up, sales person help, and relations with your industry are excellent.
4. Take advantage of your distributor. They have highly qualified service and technical personel. I'm sure that a visit to your distributors service department would be welcome and you could learn a great deal about repairing and maintaining your equipment.
5. Education of personel is becoming more and more important. Both Toro and Jacobson offer factory schools for maintaining equipment. Even our distributors offer field service clinics for your mechanics. Service manuals, operators manuals, charts, you name it, are all available to you at little or no charge.

In summary with the introduction of more sophisticated and complicated equipment, your maintenance program is of extreme importance.

Lets face it. You know where the buck stops.

Thank you.

Have a good year.

# WOODY PLANTS AND THEIR USE IN THE LANDSCAPE

by

Dr. William C. Welch*

Woody plants are those which contain woody or wood fibers and a definite cambium layer. The term includes most of our permanent landscape plants such as trees, shrubs, vines and ground covers as opposed to herbaceous annuals, turf and perennials. Landscape designers work with all types of living plants as well as non-living materials such as brick, stone and wood to create a planned outdoor environment. In most situations, however, living plants are the major material with which the landscape designer works. If his designs are to be well done and effective, it is essential that he have a thorough knowledge of the growth requirements and other characteristics of a wide variety of plants adapted to the area where he is working.

Most of us are occasionally guilty of creating chaotic mixtures of plants in our landscapes. Too often, we buy plants with no specific idea of how they are to be used in the overall landscape development. Each plant should fill a specific need--either practical or esthetic.

Plants are basically utilized in four ways: specimens, groups, masses and rows. Specimens are a very emphatic way to place plants. Too many specimens can give a chaotic effect by creating too many centers of interest. A few well placed specimens of crapemyrtle, yaupon or other plants offering year round interest can be an attractive addition.

Groups of plants add emphasis and naturalness to a planting. We often find plants occurring naturally in groups and masses. Masses are really large groups and are the way we sometimes use shrubs and often use groundcovers and trees.

Lines of plants are not usually considered a natural placement, but are often useful in privacy screens and repeating architectural lines out in the landscape. The effect is partially lost if one or more of the plants in a line dies or is severely damaged.

An important design concept to keep in mind is balance. Balance is necessary if our designs are to be harmonious, but overdoing balance can give a trite or overly formal appearance not appropriate for most of our homes today.

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It is important when considering balance to think in terms of balancing masses, not necessarily identical species or actual shapes and sizes. By so doing we create a comfortable feeling without the monotony of a formal placement.

The following lists of landscape plants are according to their use. Obviously, there are more than five good species for each category. The ones listed are generally dependable, available and well adapted for Texas.

## SHADE TREES

Trees are probably the most important landscape plants with which you will deal. Well placed and selected trees will not only make your home more attractive, but also can reduce air conditioning costs and significantly increase real estate values. The five trees described are only a few of the well adapted trees for Texas.

For more information on trees ask your County Extension office for a copy of MP-1151, "Trees for Texas Landscapes."

Live Oak. (Quercus virginiana) An attractive long lived evergreen tree. Growth rate is moderate if good growing conditions are provided. Medium size trees 6-8 feet tall growing in containers transplant very easily although larger specimens are routinely handled by experts. Give this one plenty of room.

Shumard Oak. (Quercus shumardi) All the good qualities of an oak with the bonus of frequently good fall leaf color in this area. Not as available as live oaks and water oaks, but a real asset to the landscape.

Slash Pine. (Pinus eliottii) A frequently planted evergreen pine that grows quickly. Slash pines usually grow better in sandy soils, but often do well for many years in heavy black clay. Pines are especially effective in groups. Availability is excellent and small specimens grown in containers adapt quickly.

Bald Cypress. (Taxodium distichum) Well adapted and generally available. The fine textured fern-like leaves are an interesting contrast to most of our other trees. Very few insect and disease problems and moderate growth rate are other assets. Bald cypress will thrive in low wet areas, but also adapt well to drier sites. Medium size container-grown plants transplant easiest, but larger balled and burlapped trees are also sometimes available.

Chinese Elm. (Ulmus parvifolia) There is considerable confusion among the public and in the nursery trade concerning this tree. Asking for it by its botanical name may help. The confusion is between this tree and an almost useless tree for this area often sold as Chinese elm, but an entirely different plant (Ulmus pumula). Ulmus parvifolia is a graceful, attractive deciduous tree which grows moderately fast to a height of 30 to 40 feet.

The trunks of intermediate and mature trees are especially handsome with the peeling bark revealing an orangish color beneath. This tree is available from a number of local sources.

## FLOWERING TREES

The flowering trees described here are a few of the many well adapted ones to various parts of Texas. These trees add color through blossoms and fruit and with the exception of the southern magnolia are relatively small and well suited for small properties. Another value of the smaller flowering specimens is as understory plants among our tall trees such as pines and oaks.

Crapemyrtle. (Lagerstroemia indica) An easily grown excellent source of summer color in the landscape. Whether used as a single or multitrunk tree, the character of its limbs and trunks add further interest. Colors range from white to lavender, purple, pink and red. Sunny, well-drained locations provide the best results. Transplanting is most shockless from containers, but larger specimens are also available and usually successful. A good time to buy crapemyrtle is when they are in bloom so that the desired flower color will be assured.

Goldenrain. (Koelreuteria bipinnata) Fast growth, late summer yellow flowers and showy seed pods in the fall characterize this tree. Fall is a difficult season to find blooming trees and the salmon seed pods of the goldenrain are a real show. Don't expect your tree to bloom until it has been established for at least 5 to 6 years. Well-drained sites are preferred, but a wide variety of soil types will suffice.

Large specimens of goldenrain are sometimes difficult to move. Since growth is so rapid, small plants usually give quick results. Seedlings may often be found beneath blooming size trees and may even be a pest in groundcover or other planted areas.

Southern Magnolia. (Magnolia grandiflora) The glossy evergreen foliage and huge white blossoms of our native magnolia make it a perennial favorite. Container grown specimans transplant easily, but growth is relatively slow. This is another tree that usually takes quite a few years to bloom. Since new trees are usually grown from seed, there is considerable variation in form, age of bloom and other characteristics. Availability is good.

Flowering Dogwood. (Cornus florida) The beauty of this tree is unsurpassed, but unfortunately it is rather exacting in its requirements. Although native in much of the East Texas piney woods, dogwood is next to impossible to grow in heavy clay soils. A well-drained slightly acid soil and semi-shade are best. Availability is good for the native white variety which appears to be better adapted than the pink one. If you have the right conditions, by all means plant dogwood.

Redbud. (Cercis canadensis) Fast growth and early spring blossoms are characteristics of this Texas favorite. Transplanting is a bit difficult with best results from container-grown plants which are not always available. Redbuds usually live no more than 15-20 years, but provide an unmatched source of early color and a small neat attractive tree. A more rare white flowering form is sometimes available in grafted form.

## SCREEN SHRUBS

Shrubs will not only provide privacy for our landscapes, but can also reduce air and noise pollution. Some of the ones described also produce fruit which is popular for birds and wildlife. Fences and walls are other means of achieving landscape privacy. A well planned landscape usually has a balance between construction and plant materials.

Elaeagnus. (Elaeagnus fruitlandi) A hard favorite for screen planting, but will spread 6-8 feet wide if not pruned. Grayish leaves, and highly fragrant almost inconspicuous fall flowers add to the interest of this plant. Growth is fast and availability is good. Transplanting from container specimens is easy at any season if reasonable care is provided.

Viburnum. (Viburnum suspensum) This plant is not quite as rapid growing as some of the other viburnums, but is well adapted and easily grown. It is a welcome change from ligustrum and tolerates poorly drained soils better. Good availability and easily transplanted from containers.

Yaupon. (Ilex vomitoria) Yaupon is enjoyed for its evergreen foliage, interesting trunks and fruit on the female plant. Female selections are available from nurseries although male pollen also must be in the area to set fruit. This is not a problem in many areas of Texas since yaupon is abundantly native. Growth is not quite so rapid as the other plants described, but results are usually worth the wait.

Wax Ligustrum. (Ligustrum japonicum) Popular for its shiny dark green foliage, easy availability and success in Texas gardens. White fly and poor drainage can cause problems, but ligustrum is easily available and grows quickly to form a dense screen. Some people are allergic to the white flowers which appear in early summer, but these may be pruned when in the bud stage.

Photinia. (Photinia fraseri) Provides striking red colored foliage in spring and dense screening in sunny locations. Growth is moderately fast and culture is simple in well drained soils. Although several species of photinia are available, this one appears to be best adapted to South Texas.

## LOW GROWING SHRUBS

Low growing shrubs are becoming increasingly popular because they usually require little pruning and are in scale with our homes. They are often used effectively as rows or masses and sometimes even as ground-covers.

Dwarf Yaupon. (Ilex vomitoria) Dwarf yaupon is one of the most useful landscape plants available. It is a selection of our native yaupon and very well adapted. Few insects and diseases and easy culture help make it popular and widely available. The relatively fine texture of this plant is a good contrast to larger leaf evergreens such as viburnum and photinia.

Dwarf Pittosporum. (Pittosporum tobira var. Wheeleri) This plant appears to be one of the most useful introductions in recent years. Easy culture, compact growth and shiny green leaves have made it a best seller. Good drainage is essential although sunny or partially shady locations both work well. Dwarf Pittosporum is also a good candidate for use in containers.

Dwarf Chinese Holly. (Ilex cornuta rotunda) Prickly dark green foliage and compact form are characteristics of this plant. The spiny foliage is an asset if you are trying to block traffic, but annoying if planted along walks or other areas where it may interfere with circulation. Sunny or partially shady locations are best and availability is good.

Dwarf Nandina. (Nandina domestica nana) Reddish fall and winter leaf color, neat compact growth and easy culture are landscape assets of this plant. Slow growth makes them cost more than some other plants, but dwarf nandina is very effective and permanent if given reasonable care and a well drained location. Availability may not be as good as the other plants listed.

Dwarf Azalea. (Rhododendron kurume) Dwarf azaleas are not considered easy plants to grow unless you live in East Texas, but their spectacular display of spring color makes them very popular. Well drained beds prepared with large amounts of peat moss, compost or other organic material are essential. Partially shady locations that avoid hot afternoon sun seem to work best. Frequent watering is necessary during dry periods. Kurume azaleas are readily available in a variety of colors from white to pink and red.

## FLOWERING SHRUBS

Flowering shrubs are ever popular for the color they provide in our landscape. Some are effective for screening as well as background plants.

The five species listed are perennial favorites in Texas. There are many excellent ones from which one can select.

Azalea. (Rhododendron spp.) The most popular azaleas for shrub use are known as the Southern indicas. They do best in partially shaded, well drained beds prepared with large amounts of peat moss or other organic material and frequent watering during dry spells. Indica type azaleas may grow to 6-8 feet tall. They are most effective when used in masses of one color or contrasted with white and are sometimes used for screening purposes. For a discussion of azales culture, recommended varieties and other pertinent information refer to the azalea section in the River Oaks Garden Club's A Garden Book for Houston and the Gulf Coast, published by Gulf Publishing Co., Houston.

Indian Hawthorn. (Raphiolepis indica) Many varieties of Indian Hawthorn are available. Most have light to dark pink flowers that are very attractive in the spring. Some varieties such as "Enchantress" are compact and may not grow over 3 feet tall. Others such as "Springtime" and "Jack Evans" may reach 6 or 7 feet. Partial shade or full sun and well drained beds are best. Availability is good.

Oleander. (Nerium oleander) Oleanders are very easy to grow and require little more than a sunny location. They are salt tolerant which makes them especially popular for bay area use. Some varieties damage easier during the winter than others. A "hardy red" variety is commonly sold and is rarely cold damaged in the Southern half of Texas. Oleanders become large fast and require plenty of space. They are good for screening and available in a wide variety of colors. They also root easily from cuttings. Oleanders are poisonous and no part should ever be eaten or placed in the mouth.

Crapemyrtle. (Lagerstroemia indica) This plant is our most popular source of summer color in Texas. Whether it is being used as a small tree, a large shrub or dwarf shrub crapemyrtles laugh at our summer heat and provide flowers for 3 months or more. Numerous varieties are available. Container plants can be moved successfully all year and are widely available. Open, sunny areas with well-drained soil are usually most successful.

Camellia. (Camillia japonica and Camellia sasanqua) Culture for camellias is not easy but many Texans feel that they are worth the effort. C. sasanqua is perhaps easier to grow and more useful as a landscape plant than C. japonica because it flowers more profusely and its form makes it appropriate for screening and background plantings. Information on varieties and culture are available in the camellia section of the River Oaks Garden Club's A Garden Book for Houston and the Gulf Coast. There are also active Camellia Societies several of our cities that provides good information on these beautiful plants.

## VINES

Vines have a place in almost every landscape. They can provide shade when grown on arbors, privacy when grown on fences as well as food for man

and wildlife. Few landscape effects are more attractive than a flowering vine tumbling gracefully over a fence or wall. A special softness can be achieved by using a few well placed vines.

Lady Banksia Rose. (Rosa banksia) The profusion of pale yellow blossoms and large arching canes make this plant a real spectacle each spring. Sun and well drained soil are necessary but this plant is not usually plagued with the many pests of hybrid tea roses. The foliage is evergreen and stems thornless on this rose from China. It does require lots of space and is particularly handsome on a large arbor or spilling over a wall. Availability is good with container grown plants usually available all year. A white flowering form is sometimes available.

Confederate Jasmine. (Trachelospermum jasminoides) The fragrance of the white star shaped blossoms and the beauty of its shiny green foliage make the confederate jasmine highly popular for fences, posts and trellises. Sun or partial shade is suitable along with well-drained soil. Availability in containers for easy transplanting is good. This plant may also serve as a good groundcover but is not as useful for that purpose as its close relative, the asiatic jasmine. Freeze damage occurs except in South Texas.

Carolina Jessamine. (Gelsemium sempervirens) This East Texas native can be found in many areas of Texas blooming in spring and fall with its bell shaped yellow flowers and evergreen foliage. The foliage tends to clump near the top of the structure it is growing on and is especially nice on walls and fences. Carolina jessamine is easily available and transplants from containers all year. Blooms are more profuse in the sun but semi-shady locations may also prove successful.

Wisteria. (Wisteria sinensis) Wisteria is a beautiful but rampant vine in Texas. Growth is so fast that frequent pruning may be necessary to prevent a complete "take over". Nevertheless, the effect of the purple blossoms and their sweet scent can be unforgettable. Young seedlings may take many years to flower so it is best to buy blooming size plants grown from cuttings. Various colors are available but the commonly sold purple variety is probably the most consistent and profuse bloomer.

Muscadine. (Vitis rotundifolia) The muscadine makes an attractive deciduous vine as well as a source of good fruit. Yellow fall leaf color is another landscape asset. The real reason for their popularity is that muscadines have few, if any insect and disease problems and produce good fruit for eating fresh or making jellies on a regular basis. Little care is necessary.

Some varieties of muscadines require a pollinating variety and others do not. Carlos, Magnolia and Cowart are complete flower types and do not require pollination.

Muscadines are attractive vines and work well on arbors, trellises or chain link fences. Good drainage and partial to full sun are best.

Muscadines deserve wider use in Texas. They are not always available at local nurseries. If you are unable to locate them write to Extension Horticulture, Texas A&M University, College Station, Texas 77843 for a list of sources.

## GROUNDCOVERS

Not only do groundcover plantings provide an interesting textural contrast to turf and other materials but they can also be a maintenance asset. Steep banks, areas too shady for turf and leftover spaces between driveways and houses can often be made more attractive and maintenance reduced by incorporating some of these plants.

It is very important to give groundcover plantings good care during their first two years. Most groundcovers will require little weeding after two years if they are kept weed free during the establishing period.

Asiatic Jasmine. (Trachelospermum asiaticum) This plant is probably the favorite groundcover for the southern half of Texas. Full sun to partially shaded locations are best. Gallon can plants are usually set out on 12 to 18 inch centers for quick coverage. Smaller plants are usually available and more economical.

This plant does not normally flower but creates a dense mat of shiny evergreen foliage having few insect or disease problems.

English Ivy. (Hedera helix) There are numerous varieties of this plant available with leaf shape being the major variable. It is best adapted to fairly shaded locations. Cuttings root fairly readily during the winter and early spring but plants in pots and gallon containers are usually available all year.

A variegated form is available but not as easily grown as the solid green varieties. Twelve to eighteen inch spacings are usually recommended.

Liriope. (Liriope muscari) An old favorite for bordering Texas gardens but also very effective as a groundcover. Spacing should be closer than ivies and jasmine since liriope spreads more slowly. Six to twelve inch spacings of single divisions seem to work well.

There are improved varieties of this plant available and worth searching for. "Monroe's White" is a large flowering white variety and "Big Blue" or "Majestica" improvements in the standard purple form. Liriope grows well in sun or shade although the foliage is usually most attractive when not exposed to the hot afternoon sun.

Ajuga. (Ajuga reptans) For shaded areas this plant can be a real asset. Spikes of blue flowers that appear in spring may reach 8 to 10 inches tall but the foliage is usually less. Purple, green and variegated leaf varieties are available. Ajuga is easier to establish during the cool months of the year. Single divisions placed 8 to 10 inches apart during fall or winter will usually cover by the next summer.

Monkey Grass. (Ophiopogon japonicus) This is another plant that has been used primarily for borders but is quite effective as a groundcover. It is similar to liriope but has narrower leaves and less conspicuous flowers. Single divisions spaced 6 to 8 inches will usually cover in about two years. Shady or sunny locations are appropriate, and availability is good.

# INSECT PESTS OF TURF GRASSES

by

Charles Cole*

Several insect pests will cause damage to turf grasses. Some pests feed only on the leaves and cause temporary, superficial damage. A number of pests feed on stems, stolens and roots. These pests cause more severe symptoms, sometimes damaging or killing large areas of turf. A third group of pests can be classified as nuisance pests. This group includes pests such as ants which cause unsightly mounds and which often present problems due to their venomous stings.

In order to prevent damage from insect pests one must learn to recognize the pest and its damage. Also, a knowledge of the pest's life history and habits will aid in successfully controlling the pests.

The following facts should aid producers in controlling their pest problems.

## WHITE GRUBS (Phyllophaga and Cotinis sp.)

Description - White grubs are the larvae of several species of May or June beetles. They are whitish or grayish in color, have a brownish head, six legs and usually lie in a curled (C-shaped) position. Full grown larvae may be 1 1/2 inches long.

Life history - Most white grubs spend about 10 months of the year in the ground; some remain in the soil 2 to 3 years. In mild weather, they live 1 to 3 inches below the surface of the lawn while in the winter they burrow deeper into the soil.

Damage - White grubs burrow about an inch below the soil surface and feed on the roots of grass. The damage appears as areas of dead, dry grass. Grass in the infested areas can be lifted out of the soil very easily or rolled back into a mat of runners and foliage. Grub counts of 3 or more per square foot will cause sufficient damage to warrant control.

## SOD WEBWORMS (Pachyzancla, Acrolophus and Crambus sp.)

Description - Sod webworms are the larvae of lawn moths. The adults

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are small, whitish or gray moths with a noticeable snout-like projection in front of the head. The wings are folded closely about their bodies when at rest. The larvae, or sod webworms, are about 3/4 inch long, slender and light brown in color, with dark spots along their body.

Life history - The lawn moths hide in the shrubbery of other sheltered spots during the day. In the early evening they fly over the grass and the females scatter eggs over the lawn. The eggs hatch in about 1 week, and the larvae begin feeding on the grass. These insects remain in the larval stage for about 1 to 1 1/2 weeks, then pupate. The adults appear about 1 week later. A life cycle is completed in 5 to 6 weeks, with several generations being completed within a year. They overwinter as larvae in silken webs.

Damage - Sod webworms feed primarily at night, remaining in protective silken webs covering their bodies. The newly-hatched larvae start feeding on grass and, as they grow larger, build burrows or tunnels close to or slightly beneath the soil surface. They live within these silk-lined tunnels and come out at night to feed on blades of grass.

The first signs of sod webworm damage are areas of unevenly cropped grass and brown or dying grass occurring in patches. Soon large areas may turn brown and die.

FALL ARMYWORMS (Spodoptera frugiperda)

Description - Fall armyworm adults are ash gray moths with mottled forewings which have irregular white or light gray spots near the extreme tip. The hind wings are white with a narrow, smoky-brown edge. The fall armyworm larvae are about 1-1/2 inches long and light green to almost black in color with several light stripes along the body. The front of the head is marked with an inverted white "Y".

Life history - The females lay eggs on blades of grass in masses of 50 to several hundred eggs. In 2 to 4 days the eggs hatch into white larvae with black heads. As the larvae grow, they become darker in color. The larvae are full grown in 2 or 3 weeks; then they burrow an inch or two into the soil and pupate. The moths emerge in 10 days to 2 weeks later. There may be as many as 6 generations in a year.

Damage - The young newly-hatched larvae eat only the tender parts of grass, but as they grow, they devour all foliage except tough plant stems. Damage at first may appear as whitish patches in the lawn where the grass blades have been skeletonized.

WIREWORMS (Elateridae (Several Species))

Description - Wireworms which are the larvae of click beetles are 1/2 to 1 1/2 inches long and are usually hard, dark brown, smooth and slender. Some, however, are soft and white or yellowish. The adults are about 1/2 inch long and brownish, grayish or nearly black.

Life history - The winter is passed mainly in the larval and adult stages in the ground. In the spring female click beetles deposit their eggs primarily around the roots of grasses. The adults live 10 to 12 months, most of which time, and all that of the other stages, is spent in the soil. The egg stage requires a few days to a few weeks to hatch and the resulting larvae spend 2 to 6 years in the soil. The pupal stage occurs during the late summer or fall of the year in which they become full grown.

Damage - Wireworms bore into the underground part of the stems and feed on the roots of the grass. The boring causes the plant to wither and die.

SOUTHERN CHINCH BUG (Blissus insularis, Barber)

Description - Adult chinch bugs are about 1/5 to 1/6 inch long with a black body and white wings folded over the back. The nymphs are yellow upon hatching, but soon turn red and have a light colored band across the abdomen. With each mold the nymphs more closely resemble the adults. Prior to the last molt, the nymphs are black or brownish-black with a white spot on the back and two small wingpads.

Life history - Chinch bugs overwinter as adults in almost any sheltered area closely associated with lawns. In the spring the adults emerge and begin laying eggs. The nymphal stage lasts about 30 days with 7 to 8 weeks being required to complete the life cycle.

Damage - Chinch bugs have piercing-sucking mouthparts and feed by sucking the sap from the host plant. Damage first appears as rather small, yellow or brown discolored areas. These areas increase in size as the insect population increases and as the chinch bugs move from damaged and dead plants to healthy ones. This first yellowing may be confused with several lawn diseases and other physiological disorders. Chinch bug infestations can be accurately diagnosed only if the insects are found.

When damage is severe and the bugs are plentiful, they can usually be found by spreading the grass and carefully observing the soil surface. When the yellow or brown patches of grass are first observed, chinch bug infestations can be determined by using a large coffee can or gallon can with both ends removed. Press one end of the can about 2 or 3 inches into the soil at the edge of the yellowing grass. Fill the can with water and keep it almost full for about 5 minutes. If chinch bugs are present they will float to the surface. Repeat this procedure in several different locations. Careful observation is required to find the small nymphs.

BERMUDAGRASS MITES (Aceria neocynodonis)

Description - Bermudagrass mites are very small, eight-legged pests that have caused considerable damage to bermudagrass lawns in many areas of Texas during the last few years. These cigar-shaped mites differ from those commonly seen around the home. The bermudagrass mites are oblong

in shape, whereas many of the common mites are somewhat oval.

Life history - Bermudagrass mites are capable of multiplying rapidly and can cause rather severe damage in a short time. The females lay eggs in protected places on the plant. The immature mites which hatch from the eggs go through a larval stage in which they have only six legs. This is followed by a nymphal stage in which the mites have eight legs, as do the adults. The life cycle of these mites is completed in about one week.

Damage - Bermudagrass mites damage grass by sucking the juices from the stems and leaves, resulting in yellowed or browned areas and a generally unhealthy appearance. Shortened internodes are characteristic symptoms of injury, causing the grass to have a bushy appearance. When mite damage is severe, the grass is severely thinned and weeds usually take the place of the dead grass. Bermudagrass seems to be the preferred host, but infestations have been reported from St. Augustine grass. A mite, presumably the bermudagrass mite, has been reported from coastal bermudagrass but identification has not been confirmed.

IMPORTED FIRE ANT (Solenopsis saevissima richteri)

Description - Native species closely resemble the imported fire ant; however, their mounds are small compared to those built by the imported species. Positive identification should be made by specialists. Contact your county agricultural agent for information on submitting specimens for identification.

Life history - The ant colony consists of three adult forms:

1) Winged fertile females (queens) which lay the eggs. At one stage in the life history of an ant colony there is typically only one ant - the young, mated female.
2) Winged fertile males which mate with the queens.
3) Worker ants which are wingless and usually sterile. Adult workers of the imported fire ant differ in size. The larger forms are referred to as "major workers", the smaller as "minor workers". The activities of the two are apparently the same.

The queen first lays a cluster of 10 to 15 eggs and looks after her first egg cluster almost constantly. When the eggs hatch (8 to 12 days), the helpless larvae depend on the queen for food from her body. Later the queen lays clusters of 75 to 125 eggs, and the larvae receive food gathered by the workers. The larvae pupate in 6 to 12 days and adults emerge in 9 to 16 days. A longer time is required for the development of the winged forms. Mound building by newly established colonies is not conspicuous for 12 to 18 months after the young queen initiates egg laying.

Damage - Imported fire ants are destructive, costly and a nuisance. This ant can damage many kinds of young plants by gnawing holes in roots, tubers, stalks and buds. They may attack young unprotected animals, such

as newborn calves and pigs and newly hatched quail and poultry.

The most significant agricultural losses resulting from this pest are reduced efficiency of labor and machinery - losses hard to assess in dollars. Their mounds damage machinery, prevent mowing operations and reduce the value of the land in heavily infested areas. Since these ants prefer land exposed to the sun, some of the most valuable farming and pastureland is heavily infested.

Imported fire ants interfere with harvesting of crops, since their fiery sting is very painful. Farmers lose valuable time during seeding, fertilizing and harvesting operations.

TEXAS LEAF-CUTTING ANTS (Atta texana)

Description - Leaf-cutting ants are rusty brown in color and vary greatly in size from 1/16 to 1/2 inch. Workers have prominent spines on their body and their mandibles are large and flattened. They can inflict a painful bite.

Life history and habits - After mating, the females lose their wings and burrow into the soil establishing new colonies. Individual colonies may exist for years and contain several hundred thousand ants. Leaf-cutting ants establish towns with a large number of mounds. Mounds may be 5 to 14 inches high and are crater-shaped with an entrance hole in the middle. The interior of the nest may be 15 to 20 feet deep with tunnels that lead out as far as 100 yards.

Damage - Leaf-cutting ants damage many types of plants, but do not eat the foliage they cut. It is taken into the nest and used as a media upon which the ants grow a fungus, which is the ants' only known food.

# GOOSEGRASS

by

James B. Moncrief*

Goosegrass is the species Eleusine Indica (L) Gaerta and is a common weed in the tropics and sub-tropics of both eastern and western hemispheres. It is one of nine species and the only one found in the United States. It is most frequently found on disturbed soil in the southern part of the United States, however, it has been recorded in all except the extreme northwestern states.

There are two grasses generally associated with Eleusine and they are Dactyloctenium Aegyptium (crowfoot) and Leptochloa (Sprangletop) which show a close relationship with Eraqrostis (Lovegrass).

Goosegrass is a prolific seeder and in most cases has 3 to 4 recemes or fingers on one stem. Numerous stems will be produced by one plant if allowed to mature and 15 to 20 stems have been counted on a mature plant. It is a tufted annual with few internodes, commonly reclining and being stoloni formed at the base rooting at the nodes the rest ascending, leafy, sparingly branced. The spikelets are 3 to several flowered disarticulating above the glumes in between the florets. On each raceme there are in most cases on mature plants more than 500 seed. A plant could easily produce 20,000 seed or more on 15 or 20 stems with 4 to 7 racemes.

The grain is plump with a minutely transversely rugose seed loosely enclosed in a thin pericarp. The basic chromozome number is 9. It is one of the most common weeds of the tropics and sub-tropics and is well adapted to our golf course maintenance conditions. Goosegrass does quite well where there is a poor or thin stand of bermudagrass. It seems to do quite well under heavy traffic after it is established. It has an extensive root system and all you have to do is pull up the plant to find out exactly how much root system it does have.

The seed are quite light and can be distributed quite easily becoming air borne or moving by other methods. The dust devils in the southwest distribute seed quite readily and golfers catter it throughout the golf course either with golf cars or on their shoes. The seed attaches itself to the golfers when there is dew on the grass or it is wet from rain or irrigation. The seed is tracked into areas wherever the golfers or machines

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go. Goosegrass is quite difficult to mow after it becomes established and mature. You can hear the mowers when they mow through a patch of goosegrass as there will be a different mowing sound. There is a tougher fiber inside the plant than there is in most golf course grasses. The mower must be sharp to get a favorable straight cut on the leaf or there will be a tearing of the leaf giving a brush end to the leaf or stem. There will also be a very light appearance at the end of the leaves.

Disease or insects are rarely a problem on goosegrass however in 1977, one area was observed where army worms were eating the grass and there was much of the fiber left. The army worms were so abundant this year in some areas that eggs were found everywhere even underneath the goosegrass blades as well as on top of the leaves. Diseases are seldom found on goosegrass as it seems to be quite resistant.

Eleusine Indica is known by many names, toughgrass, irongrass, dogweed, crowfoot, silvercrab, and gardengrass but goosegrass is the one it is usually called. Goosegrass is quite commonly called crowfoot especially further north, and in areas where Dactyloctenium Aegyptium does not grow.

Crowfoot is easily distinguished from goosegrass in that the cluster of racemes comes from a central apex of the stem. Also it appears that someone has taken scissors and cut the racemes in half, making them much shorter than the goosegrass. Crowfoot has become quite a pest in the coastal areas from North Carolina into Florida across the gulf and is increasing each year. It can be controlled the same as goosegrass.

One of the best controls of goosegrass is a strong dense turfgrass as goosegrass is not competitive as a seedling but as it matures, it becomes quite competitive with grasses that are growing with it.

Large clumps of goosegrass very often grow along golf car roads and where people and maintenance equipment get off or run on edges of the roads and turfgrass. These large clumps of grass produce seed throughout the summer and the seed are scattered by the golf cars and walking golfers. The person mowing aprons or fringes of the greens with a rotary type mower with the outlet under the mower pointed toward the green will throw any goosegrass seed onto the green. There will be infestation or goosegrass unless there is a healthy dense turf.

The height of mowing does not seem to eliminate goosegrass as it will produce a seedhead lying on the soil when greens are mowed at 1/8 inch. Grass that can be maintained at this height as a rule is very competitive and goosegrass has a difficult time surviving.

Both pre- and post-emergence can be used to control goosegrass and timing of application is very important.

Basic post-emergent chemicals such as DSMA, MSMA, and similar products used to control goosegrass may not be available for use on golf courses

within the next 3 to 4 years without a special permit. Chemicals that are used on farm products now are being researched for use on turfgrasses and are showing excellent control of goosegrass under proper management. Some of the chemicals being researched and showing the most promise are listed in alphabetical order, Asulox, Probe, Ronstar, and Sencor.

Asulox has been labeled for use in Florida on St. Augustine and Tifway. Ronstar has recently been labeled for use on both cool and warm season turfgrasses. The four chemicals listed have been researched throughout the bermudagrass growing area. These chemicals have given excellent control of goosegrass but there has been much damage to bermudagrass when miscalculations are made. These chemicals have quite long residuals. Tifgreen, Tifdwarf and common bermudagrass are quite sensitive to Asulox, Sencor, and Probe. Be sure to use the recommended rate when they become available for use on turfgrass.

The most common loss of grass from these chemicals has been miscalculation in calibration or poor spray equipment. Spray equipment must be in top condition and calculations must be accurate.

Small colonies of goosegrass are being observed in fairways where chemicals are not killing it. These colonies are stronger strains that are being selected by eliminating the weaker strains. You should be aware of any colonies that develop and adjust the weed control program.

Chemical control is less expensive than handpicking but some hand removal still has to be done. It is often called "goosing the greens". The fiberous roots can be cut right under the crown with a sharp instrument and removed. Do not leave any stems attached to the roots or the plant will regrow and time will be wasted. A part time employee could remove scattered plants. Hand removal will not cause retardation of the bermudagrass as chemicals can.

Literature reviewed did not mention that goosegrass seed had been found in air currents a mile high but in 1946, an entomologist had nets out of a DC-3 airplane trying to collect insects and found vasey seed at 4,000 feet. If this operation was repeated, some goosegrass and other types of grass seed would probably be found.

No doubt some of our seed came from the tropics. Literature in the 1930s and 1940s indicated that goosegrass was brought into the United States by the early settlers who used it for mulch and was found in hay for animals, as many pests were brought in.

Goosegrass is a prolific seeder and there is always a probability of reinfestation. This grass will be around for some time so be sure you have healthy, dense turf to compete with it.

# SALINITY, pH AND SULFUR

by

James A. McAfee*

Salinity refers to the accumulation of excess salts in the soil or water. Normally, most people think of sodium chloride (NaCl) as the main cause of salinity. However, excess of any salt can lead to a salinity problem. Calcium and magnesium are both salts as well as plant nutrients and excess of these chemicals can be toxic to some plants.

Salt problems are usually associated with the arid to semi-arid regions of this country. Rainfall in these areas is usually too low to leach the salts from the soil. It should be realized that salinity problems can occur in other regions of the United States. Salt problems usually occur in one of three ways: 1) salts already present in soil, 2) salt in high ground water tables, and 3) salts added to soil through the irrigation water. Salt accumulation in the soil through irrigation is by far the most frequent cause of salt accumulation. If salts are present in the irrigation water and poor drainage is a problem, salinity will be a problem.

There are three types of salt affected soils; saline, saline-alkali, and nonsaline-alkali. Saline soils contain sufficient soluble salts to injure plant growth. Sodium salts are present in saline soils, but not excessively high in proportion to calcium and magnesium salts. Permeability of these soils is good. Often, a white crust can be found on top of bare ground in these soils. Soil pH is usually below 8.4.

Saline-alkali soils exist when sodium compromises more than one-half of the total soluble cations and the pH remains below 8.5. As long as the ratio of sodium to calcium and magnesium remain even, these soils have good permeability and tilth is fair. However, when heavy rains occur, the soluble calcium and magnesium is leached from the soil and this leaves mostly sodium cations. The pH raises above 8.5, the soil disperses and permeability to water is slowed considerably. This rapid chemical as well as physical change produces a shock to the plant and can cause severe damage to some plants.

Nonsaline-alkali soils do not contain large quantities of soluble salts, but they do contain enough exchangeable sodium to interfere with plant growth of most crops. The pH usually ranges from 8.5 - 10.0. The

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dominance of sodium impairs flocculation of the soil and causes deterioration of soil structure. These soils are very poor for growth of any plants.

Excess salts (salinity) affect plant growth by restricting the movement of water into the plant roots. Water moves into the roots mostly by a process called osmosis. For this to occur, the osmotic pressure in the root has to be greater than that of the soil solution. Accumulation of salts in the soil creates a greater osmotic pressure in the soil than in the root, thus restricting the movement of water into the root. This is the main affect of salinity on plant growth. The most visible affect of salinity is a reduction in both growth rate and plant size.

Another symptom of salinity is the lack of response to applied fertilizers. Most inorganic nitrogen and potassium fertilizers are soluble salts, and when salinity is the principal factor retarding growth, fertilizers often add to the problem and do more harm than good. In saline areas fertilizer is wasted each year because the chief factor limiting growth is salinity even though nutrients such as N-P-K may be deficient. Salinity must first be corrected before the turfgrass will show a response to fertilization. These soluble salts should be leached from the soil prior to application of fertilizers.

Soil reaction (pH) is a measure of the acidity or alkalinity of a soil. A pH of 7.0 is considered neutral, while a pH below 7.0 is acid and a pH above 7.0 is alkaline. Most turfgrasses grow best at a pH of 6.5 to 7.0. As the soil pH deviates from this range, nutrient uptake may become limiting, thus inhibiting plant growth. Under slightly alkaline conditions (pH 7.5 - 8.4), nutrients such as phosphorus, boron, manganese, copper, zinc, and particularly iron may become limited due to a lower solubility under alkaline conditions.

Higher pH's (8.5 - 10.0) associated with alkali soils also affect nutrient availability. While phosphorus and iron are more available at this range, plant growth is usually restricted because of the toxicity of other elements such as alumnium, sodium, and sometimes boron. Also, under alkali conditions the sodium may induce deficiencies of other cations, particularly calcium and magnesium.

Before any steps are taken to correct a salinity and/or pH problem, both soil test and water tests should be conducted. Analyses will determine the kinds and amounts of salts present and whether the soil contains gypsum and/or free carbonates. It will also establish whether the soil is saline, saline-alkali, or nonsaline-alkali. If the soil is saline (low in sodium), the excess salts can be leached out of the soil in most cases. The important point is that drainage has to be provided to remove salts from areas where turfgrass is being grown. Without drainage for leaching, a salt problem cannot easily be corrected. Water used to leach soil should be fairly low in sodium, but fairly high in other salts (1500-2000 ppm salt).

Where saline-alkali and nonsaline-alkali soils exist, addition of soil amendments will be needed to correct the problem. Reclamation of these soils not only requires removal of soluble salts but also removal of absorbed sodium. Amendments such as gypsum, sulfur or sulfuric acid can be used to correct an alkali problem and a high soil pH problem. If free carbonates are present, sulfuric acid is the quickest means of affecting salt conditions. However, sulfuric acid is very caustic and difficult to apply.

Other amendments that can be used if free carbonates are present include: sulfur, lime-sulfur, and iron or aluminum sulfates. Of these, sulfur is the most commonly used product. Sulfur is available to turfgrass managers in three forms: a) elemental powder, b) flake, and c) granular. The granular product is the easiest form to apply on established turfgrass. For best results, apply material at aerification time to help move sulfur into the soil profile.

Table 1 shows the results of six pounds elemental sulfur per 1,000 sq. ft. on three greens. In six months, the pH was lowered approximately one unit in all three greens. However, the sodium level increased considerably during this time. This increase may reflect a change in form of sodium in the soil (soluble vs. exchangeable) and not necessarily a large increase in total sodium. This does, however, illustrate the need for drainage to correct a salt problem. Addition of sulfuric acid or sulfur to a soil increases the amount of soluble salts and if drainage is not provided, the salt problem could actually become worse.

When selecting a potential site for a golf course, check the soil and water quality before construction is started. Results of these tests should be interpreted by an agricultural expert knowledgeable in this area.

TABLE 1. Effects of six pounds elemental sulfur per 1,000 ft.$^2$ applied to three Tifdwarf bermudagrass sites in the Dallas-Ft. Worth area.

| Site | pH | | | Sodium (ppm) | | |
|---|---|---|---|---|---|---|
| | 12/15/75 | 6/2/76 | | 12/15/75 | 6/2/76 | |
| | | 0-4" | 4-7" | | 0-4" | 4-7" |
| A | 8.6 | 7.4 | 7.8 | 910 | 2,030 | 1,340 |
| B | 8.9 | 7.6 | 8.0 | 900 | 2,550 | 1,300 |
| C | 9.2 | 7.9 | 8.2 | - | - | - |

# WEED CONTROL IN ATHLETIC FIELDS

by

Bevan Cates*

Weeds and undesirable vegetation should be controlled in Athletic fields and around the perimeter of the fields for several reasons: weeds compete with Turf grass for available nutrients and moisture, or unsightly, may be noxious or harmful to mankind, increase the frequency of mowing and surpress Turf grass growth.

Weed control in Turf grass can be accomplished by two means; these being hand removal or chemical removal. Since hand removal is no longer a economical method we will concern ourselves with the use of herbicides.

Chemical weed control through the use of herbicides can be accomplished with two types of application: Pre-emergent and Post-emergent. Pre-emergent is defined as making our herbicide application prior to weed germination while Post-emergent is defined as making our herbicide application after the weeds have emerged and are growing rapidly. We can also break Post-emergent down into early Post and Late Post. In most instances we will deal with early post since the weeds are normally not in a stress condition and are still tender and actively growing. One exception might be the compound Roundup (Glyphosate) when used on tough perennials such as Johnson grass.

Most annual Broadleaf weeds and grasses such as Poa Anna, Chickweed, Carpetweed, Goose grass, Crab grass, Foxtails, Crowfoot grass, Rye grass, Sanbur, Panicum, (Texas) Knotweed, and Purslane can be controlled Pre-emergent. Compounds such as Balan, Dacthal W-75, Kerb and Simazine have proven to do a good job over the last several years. Time of application is critical for most of these compounds and the label should be read and followed.

If Perennial weeds or grasses are the problem then we would normally have to use a Post-emergent herbicide such as M.S.M.A., D.S.M.A., 2-4D, MCPP and Dicamba.

Weeds such as Dallis grass, Johnson grass, Henbit, Dandelion etc, can be effectively controlled with the above post-emergent chemicals. Again care should be taken to read the label on any product prior to its' use. These perennial weeds are most easily controlled if application is made

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while the plants are small and actively growing and yet have enough above the ground growth to translocate the chemical to the root system.

Several factors affect herbicide performance these being: temperature, humidity, wind, rainfall, soil types, target species, application equipment and calibration and last but not least the applicator.

With Post-emergent herbicides we must have adequate temperature for them to be effective and with Pre-emergent herbicides we must have adequate moisture for these to be effective.

In closing I would like to remind each of you that we must all do a better job of keeping our chemicals in the target area. This can best be achieved by using the correct size nozzles and nozzle alignment, operating at the proper pressure and speed and taking care not to spray during high wind conditions or inversions. The use of a spray additive stabilizer such as Nalco-Trol is also another means of reducing drift and keeping your chemicals in the target area.

# CULTURAL PRACTICES FOR ATHLETIC FIELDS

by

James A. McAfee*

Athletic fields using turfgrass as a cover include football fields, baseball fields, soccer fields, polo and tennis courts. Intensity of management of these various fields will depend largely on how often the field is used. While use and economics will have a large influence on the maintenance level, all athletic fields need proper fertilization, mowing, watering and aeration in order to maintain a good playing surface.

Proper maintenance is essential in maintaining a dense turfgrass cover on athletic fields. This includes proper fertilization, watering, mowing, pest management and aeration. Of these essential maintenance practices, fertilization probably has the largest effect on quality of the turfgrass.

All fertilization programs should be based on the results of soil tests. These soil tests can be conducted by the state lab or by private commercial labs. Results of soil tests will show level of nutrients present in the soil as well as the soil pH. Soil reaction (pH) is a measure of the acidity or alkalinity of a soil. A pH of 7.0 is considered neutral, while anything below 7.0 is acid and anything above 7.0 is alkaline. Most turfgrass plants grow best at a slightly acid pH (6.5-) and as the soil pH deviates from this range, it becomes harder to maintain quality turfgrass. Lime can be used to raise the pH, while sulfur can be used to lower the pH to the proper level. NOTE: All applications of lime and/or sulphur should be based on the results of soil tests.

Turfgrass plants do best when fertilized at a N-P-K ratio of 3-1-2 or 4-1-2. Only soil tests can tell how much of these major nutrients are needed to supply the plants with the proper ratio. Apply a complete fertilizer (one containing nitrogen, phosphorus, and potassium) to the entire field in the spring and again in the fall at a rate to supply 1½-2.0 lbs. actual nitrogen per 1,000 square feet or 90-120 lbs. actual nitrogen to the entire field. During late spring and summer, apply nitrogen only at a rate to supply 1.0 lbs. actual nitrogen per 1,000 square feet or 55-60 lbs. per entire field. Apply at 3-4 week intervals. Total number of fertilizer applications will depend mainly on type of turf being used as well as amount of traffic on the field. Common bermudagrass needs about 4-5 lbs. nitrogen per 1,000 square feet (230-280 lbs. nitrogen to entire field) per growing

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season, while the hybrid bermudagrasses need around 6-7 lbs. nitrogen per 1,000 square feet (340-400 lbs. nitrogen for the entire field) per growing season. Make all fertilizer applications when field is dry and then water the field thoroughly.

Proper mowing is another essential maintenance practice for maintaining a good, dense turf. Turfgrass on athletic fields should be mowed often enough so that you never remove more than 1/4 of the leaf material. This usually requires about 2 mowings per week during the growing season. Common bermudagrass should be cut at a height of 1-1½" while the hybrid bermudagrasses should be cut at a height of 0.5-1.0". A reel type mower with 5-6 blades per reel is best for mowing bermudagrass. It is especially important that football fields be kept mowed during the spring and summer months. This helps to force the bermudagrass to spread and cover thin or bare areas in the field.

A third important maintenance practice is irrigation. Proper application of water coupled with aeration and proper fertilization develops deep-rooted turf that is wear-resistant, resilient, and not easily torn by the players' cleats. Excessive water as well as too frequent application leads to soil compaction which produces a shallow root system. Water should be applied only when plants show signs of needing water, i.e., wilting, and then enough water should be applied to soak the field to a depth of 5-6 inches. Do not apply the water to run-off. If run-off occurs, turn off the sprinkler and allow the water to percolate downward and then apply additional water.

A major problem with all athletic fields is soil compaction. Athletic fields should be aerified at least twice a year; at the end of the playing season and again in early spring. Use a hollow-tine aerating machine and go over the field at least twice lengthwise and once crosswise. Aerify to a depth of 4-5" for maximum effect. Tines will penetrate a moist soil much easier than a soil that is dry.

Aeration helps to alleviate soil compaction and thus permit a free interchange of gases, particularly oxygen and carbon dioxide, between the soil and the atmosphere. Aeration likewise permits placement of phosphorus and potassium in the zone of root growth, thus aiding in the development of deep root systems.

Due to the heavy amount of traffic on athletic fields, most of them develop a thin, weak or bare cover of turfgrass after a few playing seasons. Once these thin areas develop on the field, the necessary steps for proper renovation should be conducted to help re-establish a dense, healthy turfgrass cover. First, it should be determined whether renovation will completely solve the problem or if complete re-establishment of the field is necessary.

Renovation of an athletic field usually involves the removal of all unnecessary plants (weeds), aerification and topdressing, better drainage of the field, and the replanting of certain parts of the field.

Good drainage, both surface and internal, is essential for maintaining turfgrass on an athletic field. Soil compaction occurs much faster on wet soils. To provide good drainage, the field should have a 12-18" crown in the center with smooth slopes toward the sidelines. On heavy soils, it may be necessary to tile drain the fields to help the downward movement of water from the playing surface. Some means should be provided for movement of water from the sidelines.

Once the field is properly prepared, seed, sprig or sod into the bare thin spots. Apply fertilizer every 10-14 days and keep moist until newly planted grass starts to spread. Once grass reaches 2" in height, start mowing at about 1½" and then gradually lower the height of cut until the grass is at 3/4-1". As newly planted grass matures, decrease the frequency of watering and increase the amount of water per application. Apply nitrogen every 3-4 weeks until the playing season starts.

# NATURAL GRASS VERSES ARTIFICAL TURF FOR ATHLETIC FIELDS

by

Melvin J. Robey

PRESCRIPTION ATHLETIC TURF: Will it replace artificial turf in the future? This is a question which has been asked many times in the last five years. It's a question which is difficult to answer because of the many variables involved.

When the PAT System was developed we were fortunate in that we came up with a new natural grass system just when the sports world was ready for it. Many of the professional and college teams knew they had to do something with their old grass fields or install artificial turf. The PAT System gave the opportunity they needed to avoid converting to artificial turf.

Before answering the question of whether the PAT System will replace artificial turf, a brief review of the history of the artificial turf versus natural grass controversy will give some insights as to why the artificial turf got a foothold in the sports world.

For a period starting in the late 1800s up to about 1960, athletic fields and their care received very little, if any, attention. Games were played on muddy fields, or ones which were either hard as a rock or a dust bowl. Attention was never given to the field by the coaches, players or spectators. They were more concerned with how the game was played, not what it was played on.

From 1960 to 1967 people's attitude toward the condition of the playing surface changed dramatically. They became more critical of the grass and its effect on the game. The coaches, players, and spectators now came to expect perfect field playing conditions at every game. About half of the time they went home disappointed.

Turf professionals across the country began doing research work and became more knowledgeable in the area of athletic fields and their care and construction. The problem was, it was a case of too little--too late! For years turf managers believed nothing could replace one of Mother Nature's best products--natural grass.

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During the early 60s Monsanto Company was developing an indoor synthetic carpet for use in elementary schools. Their first installation was at Mosses Elementary School in Boston, Mass. in 1966. At this time the Astro Dome opened at Houston for its first season. Immediately they had problems with the natural grass, so they asked Monsanto to produce enough plastic grass for their field. In 1967, the first Astro Turf was installed and ready for action. For the next six years, everyone in the sports world tripped over each other trying to get the "ideal playing surface" for their stadiums.

It was heralded as the perfect solution. The ideal playing surface. Mud free, less injuries, lower maintenance costs, no slipping because of excellent traction; these were just a few of the claims made by the artificial turf companies.

There was just one minor problem with all these claims. Very few of them were 100 percent true! In reality, the artificial turf companies made claims for their products without adequate experience. Today, the biggest selling point for the artificial turf is it is a multi-use playing surface. This is the point they use most often when a prospective customer mentions the PAT System as an alternate to artificial turf.

There is only one major artificial turf company still in the business -- Monsanto, manufacturer of Astro Turf. The one thing the turf industry can thank the artificial turf companies for is they caused us all to re-evaluate the situation in relation to natural grass fields. Artificial turf forced changes upon us. The PAT Sytem was born out of necessity. We had to develop a natural grass product which could compete with artificial turf.

The installation of new artificial turf fields has been reduced from the high numbers being recorded in the late 60s and mid 70s. This decrease is due to numerous factors. Increases in the cost of the artificial turf, studies showing there were not less injuries on the phony grass and a desire to return to natural grass fields are three of the primary reasons for the declining interest in artificial surfaces.

The chances of PRESCRIPTION ATHLETIC TURF or any other type of natural grass system completely replacing artificial turf in the future are not very likely to occur. The continued interest in doming stadiums and the multi-use concept will always create a demand for the artificial surfaces.

However, where fields are only used 30 to 50 times a year the trend is moving back to the natural grass fields. The lower cost of installing the PAT System and the preference of the coaches and players for real grass should result in several artificial turf fields being converted back to nature's very best -- living grass!

# BUDGETING FOR GOLF COURSE MAINTENANCE

by

James L. Faubion*

A good budget is one of the best tools a superintendent can have. If done properly, a superintendent can use his budget to measure his success, monitor his progress and aid in decision making. Budget performance is also an excellent means for club management to assess the superintendent's progress.

There are many influential factors that should be considered in preparing a budget and there are numerous methods that can be used to prepare it. Allow me to outline some of these factors and present a method for budget preparation that has been effectively used by many superintendents throughout the country. This subject matter will be presented in three categories:

I. Apparent Economic Trends In the Golf Business

II. Budget Preparation

III. How To "Sell" Your Budget

## APPARENT ECONOMIC TRENDS IN THE GOLF BUSINESS

According to the country club income and expense data presented by Harris, Kerr, Forster and Company (3) Table 1, the total revenue contribution by each club member on the Average Club Sampled have more than doubled in the last 20 years. In 1957 the average total revenue contributed from each member was $925, in 1976 it was $1889. In this same period of time, operating expenses have more than doubled while payroll and other related costs have almost tripled. The funds available for debt service and capital improvements, however, on the clubs sampled have decreased from $89 to $33 per member over the last 20 years.

Further investigation will reveal that recent energy costs are increasing from 13 to 27% per year and will continue to increase ratably in the future. Escalating taxes are also an increasing cost burden to the golf industry. A recent article in Golf Business (6) indicates the tax situation could become the demise of the industry.

Golf course maintenance costs, which are normally the largest expense item on the club budget, continue to increase from 6 to 10% per year. The Harris, Kerr, Forster sampling estimates the average annual maintenance costs for an 18 hole country club in 1976 to be approximately $154,000.

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What effect are these cost increases having on the golf industry? Some believe it to be one of the major factors contributing to the decline in the precent increases in golfers during recent years (Table 2).

Many factors affect the interest in golf and there are many opportunities for those of us in the industry to influence these factors. For example, improved junior programs should certainly be part of an ongoing program. More attention to speed of play is essential. However, as golf superintendents, perhaps the most significant contribution we could make is to accept the responsibility of providing for the golfer the MOST facility in the BEST possible condition for the LEAST cost.

It is a well established fact that one of the most effective management tools we can use to control costs is a well planned, realistic budget. And it's becomming more apparent that those involved in club management are realizing the need for superintendents who are not only quality conscious, but who also have a good understanding of cost planning and control.

## BUDGET PREPARATION

The following three phase approach to golf course maintenance is suggested for your consideration.

### 1. Determine Quality Standards And/Or Objectives To Be Achieved

Obviously, this will often require a meeting with the greens chairman, the owner or other club official to help establish objectives for the facility and determine how course maintenance standards will help to achieve these objectives.

### 2. Select Methods To Achieve Objectives And/Or Quality Standards

For example, how many men and how much of a certain type of material will be required to achieve the desired quality standards.

### 3. Calculate Cost Of Labor And Materials

Be sure that your cost estimates are accurate and are the best available for your facility.

It is important to keep in mind that no two golf courses are exactly alike (1) nor do any two superintendents think or work exactly alike, so it follows that course budgets will differ. It is worth mentioning, however, that superintendents in any given local area often face similar circumstances such as weather, soils, and insects. By working with one another, the established "learning curve", if you will, could assist you greatly in your planning and budgeting.

SOME REASONS FOR DIFFERENCES IN COURSE MAINTENANCE BUDGETS

Course Design
Climate
Local Wage Rates
Quality Standards
Type Watering System
Source of Water
Equipment
Strains of Grass
Size of Greens
Size of Course
Number of Traps

With the above thoughts in mind, we can begin to assemble a sample golf course maintenance budget. We will start by grouping the expenses into the following suggested categories:

SUGGESTED CATEGORIES OF COURSE MAINTENANCE EXPENSES

1. Payroll
2. Payroll Cost
3. Water System Maintenance - Pump repair, pipe, fittings, etc.
4. Uniforms & Linen
5. Equipment Rental
6. Equipment Maintenance - Repair parts
7. Building Maintenance - Paint, glass, etc.
8. Auto & Trucks Maintenance - Repair parts
9. Supplies - Replacement glass, poles, paint, etc.
10. Fertilizer - Fertilizer and soil amendments
11. Chemicals - Fungicides, Herbicides, etc.
12. Sand & Gravel - Trap sand, top dressing, drainage gravel
13. Seed & Sod - Overseeding, repair sod
14. Water
15. Electricity - Water pumping, maintenance building, etc.
16. Cart Path Maintenance
17. Gas, Oil & Lube
18. Telephone - Maintenance building phone
19. Miscellaneous - Professional services, sanitation, licenses, travel, etc.

Other categories will work just as well. This particular grouping serves only as one example.

In determining the dollar amount to allocate to each expense category, your past records are of immence value (2). By using these records and by trying to be as specific as possible in determining dollar amounts, we can develop a very accurate budget. It's important to keep an accurate record of all the back up information you used to determine your dollar amount expenditures. This information can later be useful in "selling" your budget as well as future budget preparation. Examples of

this back up support are shown in Tables III and IV. We have determined that to maintain this particular golf course, we will need an eight man basic crew, including the superintendent plus additional summer help. By forecasting what their future wages will be, we can calculate the monthly and annual payroll costs. These figures are presented in Table IV and then transferred to the budget. (Table V)

All the other expense items can be completed in a similar manner which will result in a budget by category and by month.

## SELLING YOUR BUDGET

Equally as important as preparing the budget is selling it. Unfortunately, this too often is a neglected step, the result being a good but rejected budget.

The key to selling the budget is "doing your homework".[4] Make sure that your objectives are the same as those who have the overall responsibility of the facility. Know that you have selected the most sensible approach to achieve each specific objective. Be able to explain the methods used to determine costs and that the methods selected are economincally sound.

Presentation - (Assume Board of Directors approval required)

Jerry Claussen[1] has outlined some excellent considerations in selling a budget which are in substance as follows:

(1) Select a convenient meeting time and place. The room should be the correct size, comfortable, with proper furniture.

(2) Duplicate the proposed budget summary and send to each member 10 to 14 days prior to the meeting. Note date, time and place the meeting is to be held.

(3) Call each member five days in advance of the meeting, ask if they received their materials and if they have any questions.

(4) Review the material with your chairman prior to the meeting.

(5) Use visual aids during the meeting if appropriate.

(6) Follow Up - Send final copy of the budget to those who should be informed.

## CONCLUSION

Consider for a moment what the indicators are telling us about the trends in the golf business. Take another look at your own particular situation and decide if some new approaches are in order. Decide if you are giving your golfing customer the most facility in the best possible condition for the best price. Are you getting the most production for each dollar you spend in course maintenance? Will better budgeting help you achieve this? If so, do it, and don't forget, the job is not done until it is sold.

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20-YEAR TREND OF
COUNTRY CLUB INCOME AND EXPENSE *

| Source of Income Per Member | | | | | Disposition of Income Per Member | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Membership Dues and Guest Fees | Food and Beverage Sales | All Other Sales and Income | Total Revenue and Dues | Year | Payroll and Related Costs | All Other Operating Expenses | Total Costs and Expenses | Available for Debt Service, Capital Improvements, Etc. |
| 1957... | $325 | $450 | $150 | $ 925 | 1957... | $373 | $463 | $ 836 | $ 89 |
| 1958... | 340 | 471 | 157 | 968 | 1958... | 393 | 486 | 879 | 89 |
| 1959... | 351 | 476 | 162 | 989 | 1959... | 410 | 491 | 901 | 88 |
| 1960... | 368 | 493 | 173 | 1,034 | 1960... | 430 | 512 | 942 | 92 |
| 1961... | 383 | 490 | 175 | 1,048 | 1961... | 443 | 511 | 954 | 94 |
| 1962... | 395 | 491 | 177 | 1,063 | 1962... | 457 | 520 | 977 | 86 |
| 1963... | 410 | 493 | 182 | 1,085 | 1963... | 473 | 527 | 1,000 | 85 |
| 1964... | 421 | 496 | 190 | 1,107 | 1964... | 484 | 539 | 1,023 | 84 |
| 1965... | 427 | 511 | 197 | 1,135 | 1965... | 497 | 555 | 1,052 | 83 |
| 1966... | 435 | 510 | 196 | 1,141 | 1966... | 505 | 560 | 1,065 | 76 |
| 1967... | 500 | 524 | 195 | 1,219 | 1967... | 532 | 585 | 1,117 | 102 |
| 1968... | 526 | 533 | 203 | 1,262 | 1968... | 564 | 598 | 1,162 | 100 |
| 1969... | 555 | 556 | 210 | 1,321 | 1969... | 597 | 628 | 1,225 | 96 |
| 1970... | 585 | 569 | 216 | 1,370 | 1970... | 637 | 653 | 1,290 | 80 |
| 1971... | 634 | 583 | 228 | 1,445 | 1971... | 689 | 695 | 1,384 | 61 |
| 1972... | 676 | 608 | 235 | 1,519 | 1972... | 724 | 730 | 1,454 | 65 |
| 1973... | 708 | 646 | 238 | 1,592 | 1973... | 762 | 767 | 1,529 | 63 |
| 1974... | 747 | 691 | 250 | 1,688 | 1974... | 808 | 818 | 1,626 | 62 |
| 1975... | 791 | 739 | 271 | 1,801 | 1975... | 867 | 894 | 1,761 | 40 |
| 1976... | 830 | 778 | 281 | 1,889 | 1976... | 909 | 947 | 1,856 | 33 |

* Harris, Kerr, Forster and Company - A statistical review incorporating operating and financial data on private clubs. Data presented represents voluntary contributions by 100 city and 100 country clubs.

TABLE I

ESTIMATED NUMBER OF GOLFERS
IN THE UNITED STATES (1)

| YEAR | NUMBER OF GOLFERS | PERCENT INCREASE |
|---|---|---|
| 1973 | 11,000,000 | 5.8 |
| 1974 | 11,660,000 | 6.0 |
| 1975 | 12,036,000 | 3.2 |
| 1976 | 12,328,000 | 2.4 |

(1) National Golf Foundation
Number of golfers playing 15 or more rounds per year.

TABLE II

GOLF COURSE PERSONNEL

| BASIC CREW | |
|---|---|
| Superintendent | $18,000 |
| Assistant | 10,000 |
| Mechanic | 8,000 |
| F/W & Rough | 7,500 |
| Tee & Green (1) | 7,500 |
| Tee & Green (2) | 7,500 |
| Irrigation | 7,500 |
| Utility (1) | 7,000 |

April - August

2nd Utility Man
$583/Month

June - July - August

3rd & 4th
Utility Men
$583/Month

TABLE III

PAYROLL

| | MONTHLY COST | | | | |
|---|---|---|---|---|---|
| | JAN - MARCH | APRIL - MAY | JUNE - AUG | SEPT - DEC | ANNUAL TOTAL |
| SUPERINTENDENT | 1,500 | 1,500 | 1,500 | 1,500 | 18,000 |
| ASSISTANT SUPERINTENDENT | 833 | 833 | 833 | 833 | 10,000 |
| MECHANIC | 667 | 667 | 667 | 667 | 8,000 |
| F/W & ROUGH | 625 | 625 | 625 | 625 | 7,500 |
| TEE & GREEN | 625 | 625 | 625 | 625 | 7,500 |
| TEE & GREEN | 625 | 625 | 625 | 625 | 7,500 |
| IRRIGATION | 625 | 625 | 625 | 625 | 7,500 |
| UTILITY (1) | 583 | 583 | 583 | 583 | 7,000 |
| UTILITY (2) | | 583 | 583 | | 2,915 |
| UTILITY (3) | | | 583 | | 1,749 |
| UTILITY (4) | | | 583 | | 1,749 |
| TOTALS | 6,083 | 6,666 | 7,832 | 6,083 | 79,413 |

TABLE IV

ANNUAL BUDGET

| | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sept | Oct | Nov | Dec | TOTALS |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Payroll | 6083 | 6083 | 6083 | 6666 | 6666 | 7832 | 7832 | 7832 | 6083 | 6083 | 6083 | 6083 | 79409 |
| Payroll Cost | 608 | 608 | 608 | 666 | 666 | 783 | 783 | 783 | 608 | 608 | 608 | 608 | 7937 |
| Water System Maint. | 500 | 1200 | 500 | 200 | 200 | 200 | 300 | 300 | 300 | 200 | 200 | 200 | 4300 |
| Uniforms/Linen | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 75 | 900 |
| Equipment Rental | 50 | 50 | 50 | 350 | 100 | 100 | 100 | 50 | 50 | 50 | 50 | 50 | 1050 |
| Equipment Maint. | 800 | 900 | 800 | 600 | 600 | 700 | 700 | 700 | 600 | 600 | 500 | 500 | 8000 |
| Building Maint. | 100 | 50 | 50 | 50 | 100 | | | | | | | | 350 |
| Auto & Truck Maint. | 50 | 50 | 50 | 100 | 100 | 100 | 100 | 100 | 50 | 50 | 50 | 50 | 850 |
| Supplies | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 250 | 3000 |
| Fertilizer | | | 8000 | | 2000 | | 2000 | | 3000 | | | | 15000 |
| Chemicals | | 3000 | | | | | | 2500 | | | | | 5500 |
| Sand & Gravel | | | 1500 | | | | | | 1000 | | | | 2500 |
| Seed/Sod | | | | | | | | | 4500 | | | | 4500 |
| Water | | | | | | | | | | | | | |
| Electricity | 500 | 500 | 600 | 800 | 800 | 1000 | 1000 | 1200 | 1000 | 800 | 500 | 500 | 9200 |
| Cart Path Maint. | 50 | 50 | 200 | 200 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 900 |
| Gas/Oil/Lube | 400 | 400 | 400 | 600 | 700 | 700 | 800 | 800 | 700 | 600 | 500 | 400 | 7000 |
| Telephone | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 600 |
| Miscellaneous | 50 | 500 | 50 | 50 | 200 | 50 | 50 | 50 | 50 | 50 | 50 | 250 | 1400 |
| TOTALS | 9566 | 13766 | 19266 | 10657 | 12557 | 11890 | 14090 | 14740 | 18366 | 9466 | 8966 | 9066 | 152,396 |

TABLE V

# PUBLIC RELATIONS: PR OR BS?

by

J. R. Watson*

Just to ask that question about public relations: Is it PR or BS? is already indicative of a PR problem. As the sheriff said in the movie COOL HAND LUKE: "What we have here is a failure to communicate."

Because public relations is first and foremost communications. But communications is only part of the answer. Equally as important is the message you wish to communicate. Let us say the message is to tell someone how good your product is or to explain its value. And the product, we should remember, can be any of a variety of things: a new grounds maintenance machine, or a candidate for public office, or a service you perform. In one manner or another, you'll find that performance is also part of the answer we are seeking.

At the risk of oversimplifying, good PR is good communications about good performance, either past or promised for the future.

But who decides what is good and what is bad PR? Any such evaluation is, of necessity, subjective. Even BS can be good communications in certain circumstances. Especially if you are the bull. And not on the receiving end.

Let me give you the definition or PR formulated by PUBLIC RELATIONS NEWS, a weekly that is widely read by the professional practitioners of PR. That publication says:

"Public Relations is the management function which evaluates public attitudes, identifies the policies and procedures of an individual or an organization with the public interest, and plans and executes a program of action to earn public understanding and acceptance."

Here's another definition -- simple, short and easy to remember: P for Performance plus R for Recognition equals PR. Take away performance and what you have is BS. Take away recognition for performance and you have an unhappy and frustrated individual or organization.

The purpose of all this effort at communication, normally, is to get someone to do something: to buy, to vote, to pass a law, or perhaps to

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appreciate you. Sometimes, it can be an effort to get someone NOT to do something: not to route a superhighway through your front yard; or not to impose a sales tax. It's an attempt, then, to influence public opinion.

And that leads us to certain basic decisions we must make before we can embark on a course of public relations with any hope of success.

First, we should know what our objectives are.

Second, we should know who our target audiences or publics are.

And finally, we should know what we have to work with: our assets and our weaknesses.

Let's start with a list of our objectives. They can be as basic as getting our work contract renewed. Or something as complex and difficult as getting a greatly increased budget for new equipment approved by the appropriate committee of your club. Write them down. The effort of verbalizing your objectives will help clarify your thinking about them. And the business of setting them down on paper will help you to decide their worthiness and their relative importance. That way, you can establish priorities and begin thinking of strategies.

Then, there is the matter of your publics. Define them. Know how many you have. For example, at The Toro Company, which is a publicly owned corporation, we have goodly number of publics. The first ones that come to mind are: our shareholders, our employees and our customers.

But within those basic categories, we can differentiate separate groups. Our shareholders include institutions such as pension funds, banks or insurance companies as well as private investors. Among the individual shareholders are Toro employees or former employees. Each of those groups has separate interests that may differ considerably, or even be in conflict with those of another group. An example that comes to mind might be a take-over attempt by another company. A good price for his stock might be the principal concern of one shareholder. But if he were also an employee of Toro, he might be more concerned about protecting present management against such a takeover.

Similarly, among our customers, we have our distributors, their dealers, the individual or entity that is the actual purchaser of one of our products; and the man who may be hired to operate the piece of Toro equipment. They are all separate audiences and if we hope to stimulate them to act in a certain way, we must know who they are and what motivates them as a specific group. This information is also important in formulating your plan of action. Or I should say your plans of action. Because, when you recognize the differences between publics then you must also recognize the need to tailor your plans to meet those differences.

Those of you who have had any military training or experience may remember that one of the precepts drummed into raw recruits is "Know your

enemy." I would change that to "Know your publics," if you want to succeed at PR. We civilians have a great advantage over the military, in that respect. We can do some testing of the market before we start our campaign. In practical terms that means we can get information directly from our publics, for communications is a two-way affair. I want to stress that point and its implications which are important. For while you are busy trying to win friends and influence people for your own purposes, you should remain open and aware of the messages that are being directed to you. They, too, constitute valuable input toward developing your strategy.

And finally, you need to know what you have to work with. Establish an inventory of your strengths and one for your weaknesses. Included in your strengths would be all of yours assets: effective allies, convincing proof of your arguments, third-party endorsements, any and everything that may be of either utility or value. And on the negative side, put down all your vulnerabilities. And learn to be brutally frank in your assessment because your opponents certainly will. And by acknowledging in what areas you fail, you have already taken the first step toward correcting them.

Let us consider for a moment the first of those assets I mentioned -- effective allies. How much of a constituency do you have? By that I mean how many people at your golf course are aware of what your job entails, what kind of preparation was required to fit you for that job, the experience you have had, the recognition or honors you have won from your peers, the problems you have solved for the club, and so on. If your accomplishments are known to a very few, you've got some hard work ahead. However, once you begin to win converts to your cause, each of them is an ally capable of helping you to spread the gospel about how good you are and what a valuable contribution you make. And their words will generally carry more weight than your own because there is no suspicion of self-interest when they plead your cause. Instead, they bring the best kind of approval -- third-party endorsement.

One of the best ways to win such allies is to be able to offer solid substantiation of your claims. That kind of substantiation comes from good record-keeping. Real evidence is what influences juries and wins cases. And it is the stack of operating schedules and records of downtimes and repairs that persuade greens committees that your recommendations for new capital expenditures are justified.

Now that you have satisfied all the preliminary requirements, now that you know your objectives, the publics you want to reach, and the means you have at your disposal, the next step is to plan your strategy. When I reach this stage of my preparation, I draft a timetable. In most cases, I know how much time I have available in which to reach my objective. Therefore, to build toward that eventuality, I must have a number of positive things happening at certain intervals. For example, it may be scheduling individual meetings with each member of an important committee. Or writing an article for a professional publication. Or being inter-

viewed by the local sports editor on what steps you are taking to keep the course in play despite the drought. It is important that you have such a checklist to make certain you are covering all the bases, and it will serve as a reminder of what still needs to be done. Once you've set your timetable, don't be afraid to alter it. Your plans must be flexible enough to take advantage of all opportunities that present themselves.

There are also things you can make happen, provided you plan carefully and in good time. But even with the best will in the world, you cannot expect to have many major opportunities. PR practice also consists of a multitude of common, little things which come from the daily application of common sense, common courtesy and common decency. It can be doing favors for others; or providing sound advice at the opportune time; sending a letter of thanks for courtesies shown; or sharing information. They are all simple ways of adding supporters for your side through service, just as the lack of courtesy can drive potential allies away.

Planning, even though it involves strategy and tactics and working out checklists and timetables, is only the second step in the public relations process. Still to come are communicating and evaluation.

We started this discussion with communications and here it is again. Which is only natural since communications runs through virtually everything we do. Someone once said that it is the cement which holds society together.

We don't need words to communicate. A baby does it with his first cry. We can communicate with a wink, a smile, a gesture, and even -- behaviorists tell us -- with body language. But whether it is done with words or gestures, communications requires a message and someone to send that message and someone to receive it.

For communications to be effective, the message must mean the same thing to the receiver as it does to the sender. And since most messages utilize words, we should make an effort to use words that are easy to understand. Whenever a difficult or esoteric or ambiguous term is used, it should be defined.

Take esoteric for a start. That means confidential, limited to a small group of insiders. We have far too much esoteric language these days, and all of us -- whatever our disciplines -- are more or less guilty. Those of us with an agronomic background use a number of terms as everyday language which might as well be Latin for outsiders.

The same can be said of lawyers, MBA's and sociologists, to name just a few. It is therefore critical that you take care to ensure that your message is getting through.

Another aspect of communicating involves the receiver. How many times do you have to deliver your message before it takes? How can you be

certain that you have achieved effective communications? Professional PR people realize that something extra must be done to reinforce their message. Rather than send it out broadside to the widest possible audience, hoping that somewhere out there are several receptive ears and minds, they take careful aim at the thought leaders, the opinion makers, the trend setters who establish the tone for the group. These are the people who are the decision makers or who have the attention and respect of the decision makers. Get your story to them and let them, in turn, influence the opinions of others.

A further consideration is that people are most frequently inclined to act in what they consider their own best interests. So you must try to couch your message in a way that points out how the action you advocate can be rewarding to the receiver. Enlightened self interest is what Eisenhower's Secretary of State, John Foster Dulles, called it. And it directs the policies of nations just as it governs the actions of individuals.

At Toro our sales messages are structured in terms of user benefits. You can take that same approach. Show how what you hope to accomplish will benefit the people you want to motivate.

Other factors that play a role in good communications are:

... good timing. Knowing the right time, the right place and the right company for transmitting your message.

... your credibility. How much confidence does the receiver have in you? That will depend upon your track record and past performance.

... and, an appreciation of your auduence. At what stage is the receiver? Is he aware of the problem? You must bring him to that level before you can hope to kindle real interest. And once there, you can then proceed to move him to action.

Evaluation, as I said earlier, is the fourth step in the PR process. In common sense terms, it means examining what you have done, measuring the results and drawing from that experience guidelines for the future. Ask yourselves the questions: How did we do? Would we have been better off if we had tried something else? Where did we fail? Did we set an impossible objective? Did we take too little time?

What you are doing in effect in evaluation is fact-finding, exactly what you did in the initial phase. And, in truth, it leads back to the first phase and you begin again, with reordered objectives, a better program and keener appreciation of what can be accomplished and how to do it.

And now, I'd like to show you two slides that depect the organizational structure, reporting and communication channels. They will serve to, in part, summarize my remarks and introduce our next speakers topic.

# COMPLETE COMMUNICATIONS UP AND DOWN

by

Palmer Maples, Jr.*

Quite often, I find a good starting place for any discussion is to get all parties involved in the discussion to agree to the definition of the words that will be used in the discussion. This you might say would be a form of complete communication. But back to my thought of this presentation ... I would like to define communicate and complete, and hope that you might accept my definition for these few minutes.

According to Webster, communicate means "to impart knowledge of" or "make known," "to give to another; impart, transmit." Accepting these meanings of the word communicate, then communication is the implementation of imparting, transmitting, making known. Now complete means "having all its parts or elements, whole, entire," having all the required or customary characteristics, skills or the like.

Someone then who wishes to have complete communication must first have all the parts he wants to transmit and then he must impart or make known these parts.

Certainly there are many areas that would be available for discussion in talking about the superintendent of a golf course and all of his responsibilities and there are many different kinds of communications.

I would like to consider these areas of this responsibility and how communication is effected by:

1) Education
2) Presentation
3) Association

The government has gotten into so many things these days and has become such a part of our lives that even these three subjects might be misinterpreted for the E.P.A. -- but it's a thought stimulator to remind us as we communicate about: Education-Presentation-Association.

Education -- One of the first thoughts in complete communication is to have all the parts. Education is how we get those parts. Education is acquiring general knowledge, and knowledge is a body of truths, facts and principles accumulated by mankind. All previous speakers

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have mentioned the importance of learning something new. That is the purpose of this conference.

I would like to relate these communications in two directions -- to the employer and the employee. Most of us work for someone else, be it an individual, a board, or a big corporation. We have someone to report to. Most of us, especially the superintendent, also have people that report to us -- our employees. As we talk about complete communications then, let us go in these two directions.

As we have the occasion to answer questions from an employer we can't properly answer if we don't have all the parts. Cannot be complete... a reason for your attendance at this conference is to get some of the parts that would be needed to add to those you already have in order to give a complete answer. The question could be on subjects from budget, equipment, chemicals, fertilizers, grass, bunkers, bridges, irrigation, shelters: anything, and if we are to have complete communication, then we must have all the parts -- education.

I mentioned attendance at this meeting as one source of the parts. Other sources are books, people, charts, records, experience, all and any source should be used to help you get as many parts as you can in order that you can best carry out your responsibility, as a golf course superintendent or whatever your job may be, researcher, county agent, equipment manufacturer, short-order cook, brick layer, whatever -- the more parts you have, the better you can carry out your responsibility and the better you can communicate.

Somebody once said there are three kinds of individuals:

1) Those who observe what is happening.
2) Those who wonder what happened.
3) Those who make things happen.

People who have all the parts make things happen.

Let me give an example. The Green Chairman asks, "Where is out-of-bounds on the left of No. 8?" Where is out-of-bounds on No. 8???

The superintendent immediately starts gathering parts for his answer. He has a responsibility, the basic of which is to provide for the member or player an area that golf can be played upon. He grows the grass: water, fertilize, air and plants the soil, he mows the grass -- equipment, lubrication, sharpening, adjustments, service repairs, paints, and he sees that the course is properly marked according to the rules so that the game of golf can be played -- by the rules. Now the rule on "out-of-bounds" states:

> "Out-of-bounds is ground on which play is prohibited. When fixed by stakes, the nearest inside points of the stakes is the line. When fixed by a painted line on the ground, the line itself is out of bounds. A ball is out of bounds when all of it lies out of bounds."

That is the Rule ... The superintendent has this as a part of his complete communication. He also has a record: three weeks past all out-of-bounds stakes were cleared around, replaced if necessary, spaced correctly and painted. Yesterday they were checked by the superintendent. With all these parts, the superintendent can make a complete and proper communication. He has all the education parts. Now another consideration comes to your attention -- presentation.

One of the points in communication is the presentation of the material. The superintendent could say to the Greens Chairman, "Why don't you look and see for yourself? It's out there." Now that presentation might be complete if complete meant the end, or finalized. It would complete the superintendent's time at that job.

By our meaning of complete communication, the superintendent would give his answer based on a knowledge of the game of golf: the rules of golf, his work schedule, records of each day's work, and his own visual inspection. His presentation would maybe go like this:

> "In preparation for the Tournament next week, I scheduled a crew to check all out-of-bounds markers. I had noticed that some stakes were missing, others had tall grass around the base and they all need some fresh paint. The crew completed their work last week; I checked everything yesterday and all stakes are visible, painted, and properly spaced. We also removed several low limbs from some trees in the area to help the golfer see his ball and determine if it might have gone out-of-bounds, or just to help locate it on the rough."

Now we have complete communication. He had all the parts and made a good presentation.

Presentation has a place for consideration in all of our communications. In the case just used, the presentation was in a verbal form. Other presentations may call for a different approach. For a budget, the presentation could include charts, pictures, brochures, a typed budget showing comparisons with other years, records of past performance, and line item description for each category. These would be required for a proper presentation, one that would inform the committee and influence their decision, one that has all the parts, and the parts made known -- that is complete communication.

But what about the other group -- the employees? How do we have complete communication with those that work for us? Let me say that this direction of communication needs to be just as detailed as to the employer. Maybe different details will be used, but it is important to include all the parts and consider the presentation.

Let us use the same example. After inspection and determining that the out-of-bounds stakes should be checked, cleaned and painted, you make

an announcement to the crew: "Somebody go fix up the out-of-bounds markers this week." With that kind of instruction, what is expected to take place?

Do you really expect things to get done if all instructions are given in this manner? Certainly the superintendent has not carried out his responsibility to his club or acted in a professional manner. He has not demonstrated his ability to do the job correctly and you would question his whole operation and management ability. Management is getting things done through people -- but with management comes the need to:

1) Define the objective.
2) Establish a plan.
3) Assign responsibilities.
4) Re-evaluate as the project progresses and communicate.

The man in this case has done none of these. Properly done, the action may be like this:

> "John, I've noticed some of our out-of-bounds stakes need cleaning around, some need to be replaced, and all could use some fresh paint. We must keep the out-of-bounds defined so the players know how to score the hole. There is a Tournament in four weeks that we are preparing for and this is a good time to get this job taken care of. When Joe and Charlie finish their green mowing assignment this morning, have them get some new stakes, paint and the necessary tools to clean around and drive new stakes. Check all stakes around the course and especially along No. 8. We have had some vandalism in that area and some stakes are missing. This should take a couple of days to finish -- just let me know when it is completed, or if you have a problem."

In this case the superintendent has shown some managerial education. He set the objective, described the plan, has a time estimate for completion, and instruction on how to get the work done. He has also supplied parts of Why - What - Where - How - When -- those familiar terms we have so often used. He has had complete communication, different details than for the Green Chairman, but details <u>necessary</u> and <u>meaningful</u> to the one with whom he was talking.

His presentation was acceptable to his employee. No shouts -- clear explanation and instruction, and a way open for input if desired. The superintendent has used education and presentation in his communication.

How about association -- where does it fit into the picture?

My reference to association is used to demonstrate that as a <u>group</u> gets together, shares its problems and solution, the individual participant benefits mostly in his education aspect. GSCAA is an association,

a group of individuals that has presented information to its members for their education. Seminars, magazine, conference and show, and support of research and scholarship.

Much of this information, or parts, has come from fellow members. They themselves have benefited from other meetings and are willing to share what they have learned. The subject could be agronomic, business, management, whatever. Complete communication can be helped by association -- those national in scope, state oriented, or even down to the association with a fellow superintendent over a cup of coffee. This Texas A&M Turfgrass Conference offers to its members many parts that can be added to one's collection of ideas, thoughts, and facts and help him be more complete in his communication.

Now another meaning of "complete" mentioned earlier is to finish, to bring to an end. I am just about ready to complete my presentation. I hope I have communicated to you the advantages of learning as much about your responsibilities as you can. Use all of your associations to improve yourself and each time you try, "Y'all can communicate completely..."

# LANDSCAPE DESIGN -- PARKS & GROUNDS

by

Dwight S. Hall*

Good landscape design provides a maximum of enrichment and usefulness. Good landscape design in parks and public areas provides an experience for many people. Public landscapes, although appreciated by the public, are usually abused by the public, and maintenance and general upkeep becomes a major criterion for design solutions.

## General Considerations in Public Landscape Design

--Always plant with a definite need in mind...not simply for the sake of planting.

--Understand space.

With each landscape entry, space is affected. Compared to an empty room and the effect of a chair, mirror, etc., in that space.

Understand how one space and its function affects a neighboring space and how all the various spaces and functions will work as a single unit.

Understand how people react to various spaces.

--How to create spaces with plants.

Group plants together in lines and masses to give definition to space and to create a unity.

Curved lines should be strong enough to provide a definite meaning.

Consider solid masses versus open, baffle effects.

Consider how one plant mass plays against another or how a plant mass is displayed in conjunction with a building or structured mass.

Consider the leftover or "void" space and its design impact. It becomes equally important in the total design concept.

--Unity.

A oneness of design.

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How to bring all the various functions and bits and pieces into a harmonious total.

Achieved by repetition of the same design element or of the same plant or repetition of lines or masses.

--Scale and proportion.

Outdoor space must be scaled in design to meet the intended function. A park bench may be intimate and secluded, whereas an open meadow may be open and vast--each having its intended function. Walks and drives must be scaled to accommodate intended usage.

Plants as well as all landscape entries must be in scale and proportion to its surroundings and its intended function.

Allow large shrubs or small trees to make statements in large areas. Use small details in closeup areas where people circulate.

--The leftover spaces.

These can very easily become the problem maintenance areas rather than a challenge to design. Consider as an area to play upon the senses... a visual impact or one that supplies sound of water, etc.

Allow the desired natural to prevail where possible.

--Simplicity.

The key to all good art, whether painting, music, drama or landscape design.

KISS -- "Keep It Simple, Stupid."

Only plant in accord to need.

--Avoid monotony.

Over simplification leads to monotony. Too much same color, too much same note, too much same plant may provide simplicity but becomes boring and uninteresting.

--The accent plant.

Accents are explanation plants in the landscape design. They provide emphasis and impact. They should draw the eye to key locations. Too many accents lead to confusion and lack of emphasis.

The single plant standing alone usually becomes an accent.

Key areas of accent include entrances, elements to draw the eye to a desired location and areas where you wish people to physically move.

--Maintenance.

Careful selection of plants will help reduce maintenance.

Use of plant in regards to size and natural character will reduce

maintenance.

Groundcovers in problem areas such as inclines and beneath trees can strengthen design and reduce maintenance.

Annual and perennial plants will add maintenance, therefore should be limited or in accord with maintenance budget and work crew.

Good design that specifies definite use areas will help reduce or at least control maintenance.

Each plant entry is automatically added upkeep.

Plant placement, spacing and grouping should be done with maintenance equipment in mind... allowing mobility of equipment to its best effect.

A poorly maintained landscape becomes an unpleasant experience. Better to have had no planting at all. If a choice must be made between unkept marigold plantings and bermuda, take the bermuda!

# COLOR ACCENTS WITH HERBACEOUS PLANTS

by

Everett E. Janne*

Herbaceous plants - what are they? The term is used rather glibly by the gardening public, and everyone assumes the other person knows what is being discussed. The word herbaceous comes from the word herb and means herb-like. What is an herb? To some it is a plant or plant part used for flavor or seasoning. To others it may mean a plant or plant part used for medicinal purposes.

In this discussion it is defined as a seed plant with little or no woody fiber in its structure which, after flowering and forming seed, either dies as does the annual plant or the top dies back to the ground and resumes growth the following season from the underground part as is the case with most perennials.

The present day landscape designer has wide array of herbaceous materials to choose from. Through the advances in plant genetics and improved practices in plant breeding it is now possible to enjoy flower color in the landscape the year round. The designer not only has a choice in time of flowering but also within a given species he has a choice in flower size and color as well as a choice of plant size he may need for a specific spot or purpose in the garden.

The problem confronting the gardener is selecting the varieties of annuals and perennials best suited for his area, in the color and size he needs. Floral test gardens have been established throughout the United States to provide the public an opportunity to view the products of the plant hybridizers as they become available in the garden center and nursery trade. One of these is located on the Texas A&M campus and another at the Dallas Research and Extension Center.

The role of herbaceous plants in the landscape is usually considered as auxiliary because of their temporary influence on the garden scene. Woody plants and lawn grasses are used as dominant features in the landscape because of their more or less permanent nature. Herbaceous plants are used to provide much of the seasonal color and serve as accents when at their peak. Once their period of glory fades from the scene, they should disappear into the background or be completely removed from the landscape scene. The variety of plants in this important group is almost without number.

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The annual forms range from amaranthus to zinnia with all of the alphabet in between including calendula, marigold, petunia and others. Among the perennials we have the great variety of bulbs and bulb-like plants as well as dianthus, delphinium and chrysanthemum and a host of others.

Herbaceous materials are utilized in many ways in the landscape; however, they serve most frequently as accents or attention getters. The appeal to the emotions of the viewer. Have you ever gazed upon a mass of red or white tulips in early spring and momentarily become spellbound by the scene? The blaze of color stirs the emotions, especially if the scene follows a rather severe winter with little or no bright color remaining in the landscape. The sudden brilliant display of color seems to appear with little warning.

Scenes like this "don't just happen", they require planning and proper installation to be effective. For instance here in Central and South Texas, tulips require special chilling to be effective. Even though properly chilled, if they are planted too early, the warm soil will negate the chilling effect. If the bulb beds are to be over-planted with pansies or other cold hardy plants, it takes a lot of planning, time and labor to utilize the two together effectively.

Unfortunately, herbaceous plants have periods in which they are not extremely effective as accents. During this time one must have other areas planned to serve as highlights or else maintain a separate growing or production area in which the plants are grown in containers and moved into place as soon as they are in prime condition replacing the previous planting.

When using herbaceous materials, give careful consideration to the amount of time and money that will be available for maintenance. This should have a marked influence on both the amount of space allocated to the use of annuals and perennials as well as the type of plants selected. Time and labor have become extremely important even for the do-it-yourself gardener whether in a park, golf course or home. Unfortunately, it is the unavailability of finances that determines the amount of space devoted to the use of herbaceous plantings in the landscape. I would much rather see a minimum of well-maintained herbaceous material than to view large areas of well-designed annual beds and border plantings that are in poor condition due to lack of maintenance. A few small well-planned flower beds are much more effective than large areas devoted to neglected plants and vigorous weeds.

Herbaceous materials should be incorporated in the design so they will be seen at their prime and then either fade into the background or be removed and replaced with a minimum of effort.

Flowering herbaceous plants are usually used in the landscape as flower beds, flower borders, cut flowers, or as specimens. Usually the cut flower garden is relegated to the service area since the individual flower is of great importance and they are usually used for interior enjoyment. When

kept to themselves the plants can be staked, supported, pruned and otherwise properly cared for without cluttering the rest of the landscape.

The flower bed is a definite design element which stands by itself. It is surrounded by walks or lawn area and sometimes defined by a low sheared hedge. Flower beds are difficult to use effectively except in a formal landscape or possibly in some of the more contemporary gardens where mass effects are needed and there is adequate labor available for maintenance.

The flower border is easier to use since it is viewed from one side only and has some type of background to show off the flowers effectively. The background may be a fence, wall or shrub planting and should be dark in color or uniform in texture and color to be effective.

Flower borders are most effective when used on the incurve area of a long sweeping landscape curve created by a bold planting of shrubs. Use shrubs with fine textured leaves for the background and bolder or coarser leaves at each end of the flower border. This allows part of the border to be hidden from view until the beholder comes around the end of the outcurve and the full view of the planting is in front of him.

Colors in the flower border should please the eye. The traditional color wheel serves as an excellent guide as you plan the border. Since the green, blues and browns make up the dominant colors in the landscape, they tend to soften the effect of the warmer colors allowing color combinations in the landscape that would be impossible in other situations.

As a general rule warm colors should be used in sequence with a gradation from red to white. To be pleasing to the eye, the gradation must be smooth and gradual. The smaller the area, the fewer colors one should use. In a very small area, limit yourself to using one color and achieve a pleasing effect by using several shades of the same color, as a light pink to pink to dark pink.

Illusions in the garden can often be achieved by using color. Cool colors used at the rear of a very short area will give a feeling of greater depth, whereas a long narrow vista can be made more intimate by using strong warm colors at the rear.

Walls, shrubs and simple screens will serve as effective backgrounds for herbaceous planting. A house or building is not an effective backdrop, as the architectural features tend to dominate. Flower borders in such a situation need shrubs placed behind them to stabilize the planting. However, annuals do serve as effective accents for architectural features if used correctly.

Annuals serving as specimen plants are usually individual plants growing in containers and used for accent or contrast on the patio, terrace or porch. They should not be considered as low maintenance features. The container should be selected with care, attractive yet not showy or

it will compete with the plant for attention. In other words, containers should compliment rather than detract from the plant. I am sure you have all seen containers used that seemed to steal the show. Many of the annuals are extremely effective as specimen plants. Bulbs can also make interesting container plants providing color for outdoor areas. Another container being featured is the hanging basket. The plants that can be used in this manner is almost unlimited.

In summary let me point out that for effective use of herbaceous plant materials in the landscape the designer should:

1. Let simplicity be the keynote.
2. Balance their use with the amount of time and labor available for good maintenance.
3. As with any landscape feature allow time for enjoying their design and beauty.

# ORGANIZING GROUNDS MANAGEMENT OPERATIONS

by

J. Alton Enloe

A year ago tomorrow I addressed the Parks and Grounds Session of your Annual Conference on the very specialized subject of "Earth Scars." Today, my topic is much broader in scope. I consider it a much tougher assignment. I can imagine that your management of the earth scars in your landscape operations is not much different than it was a year ago even if you heard my presentation. I must confess that mine are not either and I gave the talk. This is true because of 1) the limited number of factors we can vary in such operations and 2) the day-in, day-out difficulties in implementing all our good intentions. I take a little solace in the fact that some of my critics now recognize that while a cat in a sand box can dig a small hole, walk around it a time or two, and refill it without much of the world noticing, the grounds manager whose basic growing medium is gumbo clay might have a little more difficulty smoothing such disturbed areas in his part of the world. An added difficulty is the fact that most of our bosses imagine themselves as experts of a sort in personnel management regardless of their technical training, and while they may delegate earth scar removal more or less completely to our domain, most of them want an ongoing hand in our organizational affairs involving people and other highly visible items like money, shiny equipment, etc. In many cases, where larger public institutions are involved, even the bosses get a "helping" hand from Personnel Departments who sometimes come through to Grounds Supervisors like myself as seeing themselves as omniscient servants who, like kings of old I suppose, can do the working man no wrong. Well, I have some news for you. Physically, it is one tenth of a mile from my office to my boss's in the General Services Building on the Central Campus of the University of Houston. Psychologically, it's probably a mile and I figure about another nine to higher management's ivory towers from our ground entrenchments "where it's at." For example, as I mentioned in a presentation five years ago at your Turfgrass Conference, I felt we line supervisors were being asked to do in a few short years what, collectively, we have failed to do since the Civil War in affirmatively implementing equal opportunity in this country. I regularly realign my aim at this goal and, not surprisingly I suppose, am learning a little all the time about prejudices, their sources, and some of the difficulties in their eradication. I have come to question long-standing personnel procedures like the exit interview and sin-

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cerely wonder about its constitutionality even though I have been legally over-ruled at the University of Houston where I have experienced the consequences of its abuse. I did find myself actually promoting an exit interview four Friday mornings ago, however. On that particular morning, I arrived in my office at approximately 7:00 o'clock and found on my desk a personnel memo attached to an Equal Opportunity brochure extolling the virtues of exit interviews. The passage was highlighted in yellow ink. Obviously meant to be brought to my attention were comments on all the good information that this procedure can produce. My grudging resentment gave way to gleeful obedience at 8:00 when a disgruntled employee who had been terminated two days before showed up ready to "break my Lawn Care Foreman's neck." I could not wait to get him to Personnel to see what we would learn from his exit interview. The main thing I heard we learned was that underneath his top coat, he carried a butcher knife. Personnel at last knew what a faithful foreman had known for several weeks--we had an employee whose performance was less than satisfactory. Even this tale has a twist of irony in that the foreman was judged harshly for having tolerated such an employee for so long. Life's not easy down in the trenches, these days, and perspectives from that vantage point should be verbalized as respectfully as commands from on high are spiritedly issued to get it all together.

## Commitment to Excellence

Good soldiers always follow orders. Wise commanders listen to their troops. The unbeatable combination comes together when all can agree on what is right and find it in their hearts to move in that direction. I do believe that we, who find ourselves in the trenches, have the moral obligation to help define what is right for all groundskeepers. I can thank Personnel People at the University of Houston for even ever having heard of Blake's Grid which is a graph of sorts defining characteristics of good grounds managers. How many of you have ever heard of Blake's Grid? Even if you haven't, you already intuitively exercise the leadership traits it suggests or you wouldn't be where you are today. Some managers do lead predominantly by setting high production standards and using every means at their command to attain these goals. Others feel, according to Blake, that they can get their jobs done more socially by looking after (catering to, I call it) their employees' every whim and letting the employees work when their conscience prods them forward. One begins to think about where one fits on the graph when Personnel People continue to explain that other Grounds Managers actually lead by doing nothing except being neutral and accepting various suggestions while letting different employees fill the vacuum they deliberately create in their organization to bring out the best in their employees. I suppose that everyone does as I did when I first heard about Blake's Grid and his characterization of the firm-fair Grounds Manager which sounded ideal to me. At that point, I overlooked that fact that Blake may or may not have been trying to suggest which traits were ideal as he described those known to exist in various Grounds Managers around the country. I even became

aggravated enough with Personnel to suggest that we no longer need the social characteristic that Blake says some Grounds Managers use to oil their organizational machinery since, down in the trenches, we still have to get the grass fertilized, cut, and watered simultaneously implementing EOE, EPA, and OSHA requirements for a rapidly changing Groundskeeper Population which get paid by computers, regularly get their rights and fringe benefits explained to them by letter, memo, or newsletter mailed directly to the employee from Personnel, the Attorney General, or some other socially-caring individual other than their bosses. I might have been closer to the truth than even I dared to admit when I suggested that certain natural bents in one individual leader can now be separated into completely autonomous departments such as Personnel Management and our Grounds Department at the University of Houston. These divisions may be logistically and administratively easier for top management to control. I maintain that many of the employees whom I am expected to manage now think their bread is buttered somewhere other than in the University of Houston Grounds Maintenance Department. Even if they are totally wrong, I think you understand the consequences of such schizophrenias.

I am probably wrong in another area involving Personnel, but I'd like for those of you who find yourselves on ground much like I tread these days to consider one possible EOE ramification of centralization of employment referrals and screening in Personnel Offices across this land. I have verbalized to my boss that the office of the seat of discrimination has merely been moved from hard-line, possibly prejudiced Grounds Manager offices to one central office in Personnel Divisions. In theory this may be fine. Practically, since Personnel employees are human, too, I suggest to you Grounds Managers concerned about all facets of your future organization, that you openly question the fairness of the central office which may or may not be more prejudicial in their hiring practices than you have been down through the years. Again, I can live with many organizational schemes, but I sorta have to believe they are right. My point of all this is that we Grounds Managers need to study our rights as employees of higher management and as managers of employees who are being coached very well, indeed, these days concerning their "rights." We are all committed to excellence in our operations. Over the Grounds Department bulletin board at the University of Houston Central Campus is the suggestion "Knowing Leads to Success; Not Knowing Leads to Failure." Even if not knowing only leads to hesitation as you work to organize your operations, this can hinder the teamwork so vital to excellence in all areas of life.

## Organizational Size

Before I ramble on too far, speaking as though you all have 50-100 man operations, let's briefly consider the effect of size on organizational efforts to direct a group of individual groundskeepers. First, let me say, some of the most efficient operations I have observed during my grounds management days have been one-man operations. Lucky are the employers who have a slot for only one individual and who manage to find

that person with just the right amount of ambition (and it's just as easy to have too much as it is too little), knowledge to integrate all the specialized tasks farmed out to individuals in larger organizations, and responsibility to accomplish the desired goals of higher management without someone looking over their shoulder all the time. Such an individual integrates better than any computer the needs of his job and accomplishes them on schedule with greater flexibility than any timekeeper could possibly expect of more externally-programmed individuals. Granted, many of these one-man operations are small and, of necessity, must be kept that way if landscaping requiring a high degree of maintenance is involved. Otherwise, standards are adopted which require less maintenance for acceptable accolades and there are many such standards if we teach our employers of their acceptibility. This time of the year, I often think of my first boss at the University of Houston, Stephen Sakach, who questioned what was wrong with a few leaves on the ground during October and November. What better way for our students to learn why our forefathers termed this season of the year "fall" than to shuffle their feet through rustling leaves which had "fallen" from above proclaiming one of man's most useful and readily available energy-management devices--deciduous trees? There are some virtues of less complexity in grounds maintenance. Once, I even heard a landscape design glowingly described as an example of "Elegant Simplicity", two words which become more meaningful to me each day I age.

I must hasten to agree with those of you who know of less-than-successful one-man grounds operations. Lord knows, they exist. We have all heard of operations which run about 50% right(usually described in units of anatomy rather than percentage points) and I would be the first to agree that a bad choice of a groundskeeper in such one-man operations is just as fatal as 50 wrong ones in a 100-man operation. After thinking about it a little while, I guess I am glad we have a Personnel Department. Self-righteously, I can claim all 50% of the right choices at my Institution--and is there any question in anyone's mind who makes the other 50%? How's that for passing the buck? Incidentally, much of your effort in organizing larger grounds management operations should be aimed at this phenomenon. I can't say too much about the devastating havoc divided responsibility can wreck in your department. Intuitively, we know this. All we have to do is look around at some of our larger federal bureaucracies so evident throughout the world today and listen to unending tales of inefficiency in such large organizations. The question is, "Will we take the time and sometimes brutal steps necessary to confront the issue and smooth bruised egos as we ferret tasks around the most logical logistically-supportable organization we can build?"

Call it identity, call it pride, call it buck-passing stoppage, call it whatever we will, we must get our people on tasks most agreeable to them and amenable to the productivity required to keep us in business. Having done this, the next step is to curtail detouring which is as hampering to grounds management operations as it is to hunters whose dogs get on cold trails in deep woods. The frustration of the tactic for the

grounds manager and the hunter alike is that neither can really fault their operator who may, indeed, be working harder than the employee or dog which is heading directly toward the desired target. Even your immediate boss, let alone your impartial Personnel Department, won't understand your tirades because of such actions. Very simply, we must be sensitive to this waywardness while trying to understand, mortal as we are, that some meandering may indeed be the best course for a flowing organization. As your organization gets larger, the intensity of your maintenance is very likely to increase because so many people are involved it is simply expected. With this increased complexity comes increasing sophistication of your equipment needs and operator skills, and surely the need for more operating funds.

## State of Texas Grounds Maintenance Formula

This brings us to the need for a gauge to measure something of expected grounds maintenance costs. This is particularly true for bosses and higher management who somehow sense that even personnel directly in contact with grounds maintenance operations often find it difficult to project their exact financial needs in times of horrendous inflation, high worker-expectations, etc. Our answer in Texas for institutions of higher learning is the formula SW(.70P + 122L + .50E) which may or may not reflect our real grounds maintenance costs because of so many averages of so many variables whose costs have not actually, completely been tabulated. It's virtue lies in the fact that, on paper, it allows increases in most grounds maintenance budgets across this State. I certainly cannot object to this dream, but I am fearful of the day when, after its firm acceptance and entrenchment, our Texas Legislators decide we must do with less and (based on averages which is the best way I know to fall from excellence) budget less than full-formula allocations. Before that day arrives, I would urge each of you to apply the formula to your operations and determine if it really measures grounds maintenance costs or merely averages a wide variation of operations surveyed across Texas.

## Tulips or Tear-Away Jerseys

Speaking of cutting costs, I read an article in the MANAGER'S MEMO, official publication of the Professional Grounds Management Society of which I am a member, about the threat tulip bulb growers in Holland face because of their reduced sales in Europe and England. Only American orders have sustained the sales of flowering gems which have been developed over the centuries for our "amenity horticultural" organizations and add so much to the quality of our environment. Soon after I read this article in the MANAGER'S MEMO, I watched Texas University play Baylor on National TV. Earl Campbell's tear-away jersey was replaced several times during the game and at $8.00/jersey and an average of seven lost/game over a 10 game period, this cost would amount to over $500-a figure akin to our annual expenditure for the Holland tulip bulbs

we plant each year on campus. My how times change. When I reflect that I played every play offensively at quarterback and defensively at linebacker my junior year in Hull-Daisetta High School and had to steal my jersey (well, I actually didn't steal it, I just didn't bring it back to school after my Mom washed it following our last game that year in 1945) to have it around the house, I have to wonder about sophistication and elegant simplicity. Don't you? As I wonder about this particular situation, I can't help but think of Fred Akers. Now there's a guy who has done alright trailing a tough act to follow in Darrel Royal who probably recruited Earl and at least sanctioned, if not innovated, the tear-away jersey. Fred's real test will come two or three years from now when his own recruits will be front and center and he is forced to introduce a few innovations of his own. I have one suggestion for him that I feel reasonable sure would work with his white athletes at least--tear-away pants! Like Earl, I probably could have broken one or two more tackles with tear-away jerseys like he wears. But I betcha I would have broken a lot more if I ever appeared before 60,000-70,000 people to play football in tear-away pants. I can tell you one thing, if they ever got tore-away, there'd be no stopping me until I was back in the field house. Tear-away pants might have a disadvantage if the dressing room happened to be behind my own team's goal line. Then, too, some of those "strange" fellows might show up for football practice if they thought they had a chance to legally streak up and down a football field with its stands crowded to capacity. I sorta doubt that Mr. Akers will extend himself so far just to be innovative. Neither should we as Grounds Managers but I do believe it is time we get our act together to convince the world that tulips are at least as valuable as tear-away jerseys. Since I have been jesting a little, you might think I am still kidding about "amenity horticulture" priorities in a changing world. Let me assure you I am not.

## A Little Vengeful Sidetracking
## or
## An Introspective, Respectful Suggestion

Affirmative action to implement Equal Opportunity Employment mandates is such a big factor in grounds management operations at this time in history that cutting grass seems minor on some days at our Institution compared to the management "cool" needed to smooth wavey waters emitting directly from the high expectations being drummed into young people of all races. If my observations of our progress are anything like representative of what is really happening in our operations, I'd have to say that we have succeeded only in changing some seats of prejudice as I mentioned earlier. I'd question whether we have reduced or, in some cases, increased racial prejudice in many pockets of our operations.

I took to heart a "spirited" affirmative action speech by the President of our Institution several years ago and redoubled my efforts not to be among those he chided for not affirmatively implementing Equal Oppportunity. Since that time I have received no accolades for my efforts, bungling though they might be, have many emotional scars for the few ef-

forts I have made, and would have to admit, honestly, that I may be among those more prejudiced today than when I tried to enter into the spirit of this movement. Perhaps the fact that I have seen, first hand, some apparent "seat changing" with no "heart changing" has increased my amazement at the lack of understanding in high places of the ramifications of some Equal Opportunity admonitions. At this time, there really is nothing else to do but "Go ahead, on" as my black buddies are still occasionally heard to suggest. Identities, which are so valuable in grounds management operations as I suggested earlier, must grow from roots deeper than a few layers of skin. Formerly lily-white institutions such as the Baptist Church with which I still identify need only to look to the author and finisher of their faith, Jesus Christ, to see beyond the bitter racial prejudices which have kept them from serving a large population numbered among these commissioned to us in Matthew 28: 19, 20.

Likewise, institutions such as the Central Campus of the University of Houston System and Texas Southern University with their respective white and black roots must now look to education and research for their identifying commitment in history and if this commitment is also going to be excellence, the two Institutions have no alternative but to merge and become one tremendous example to the true spirit of affirmative action in Equal Opportunity. This is the introspective, respectful suggestion of this part of my discussion on organizing grounds management operations. I suppose if this suggestion were really taken to heart as I sincerely hope it will be, then I must prepare myself as much as Howard Green, TSU's Grounds Supervisor, to accept a flip of a coin as the only fair way of deciding who would manage the grounds of the tremendous Institution developing from this merger. I don't think anyone ever thought Equal Opportunity would not cost something. This particular merger would test the depth of affirmative action convictions in high places at both Institutions. It may surprise some minorities, who have had only high expectations drummed into their thinking, that ground already paid for by whomever may be guarded a little more tenaciously, and perhaps rightly, than they have been led to believe. After all, commitment to excellence is the name of the game.

Now, for a little vengeful sidetracking. The predominantly white Central Campus of the University of Houston System is separated from predominantly black Texas Southern University by one small city block. I have verbalized to my boss some of the difficulties I have experienced trying to manage the grounds along Scott Street which borders the University of Houston and separates us from Texas Southern University. I am reasonably sure that some of my employees do not identify with that part of our campus, and I wonder how many people on the west side of Scott have really conceded the ground to us. Most of the time, I am not proud of our grounds management operations in that area. Since I have heard very little from higher management about it, I assume they are not very eager to claim it either or flatly recognize the Herculean effort it would take to "overcome" in that area. The grounds involved are naturally a little "messier" than some other areas on campus because of athletic events, structures such as Jeppesen Stadium, and many acres of parking for basketball, football, rock concerts, etc. located in that one area. Presently, Jeppesen Sta-

dium is too small for Cougar football crowds, and we even have trouble scheduling some of their Southwest Conference games in the Astrodome. Thus, a need exists today on the Central Campus of the University of Houston for larger facilities to accomodate our athletic program which, from time to time, exerts an obvious commitment to excellence. Thus, if we could get a few more whites to grant that some black athletes probably are worthy of excellence consideration, we could buy the block separating the two Universities and build a gigantic athletic facility to accomodate both schools (or wouldn't one be better?). Sprig Flowers, Shrub Care Foreman on the University of Houston Central Campus, knows that I personally, will concede running ability to some black athletes. In fact, we have been able to laugh a little about Alex Haley's "Roots" which we agreed should have been aired on national TV. Sprig also agreed with the thought that none of my ancestors ever owned any slaves because, after watching me on our grounds, he is convinced that I never could have caught the fast-stepping Kunte Kinte and probably would have had to pick my own cotton.

Speaking of cotton, radio and TV announcers who follow University of Houston Central Campus Cougars might have a little trouble describing the action of a combined Cougar-Tiger (crossed cats?) team from the University of Southern Texas at Houston (USTH) against an outside foe. The Southern Texas part of the combined University name would salvage some of Texas Southern's identity as well as South Texas Junior College, now called the Downtown College of the Univeristy of Houston System. The US would look like us and the TH like them and I suppose its just a matter of growing accustomed to USTH like we have to UCLA and USC. I doubt that decision will be a grounds management function to settle anyway. Thus, I will leave this respectfully submitted suggestion to higher management of Texas Southern University and the University of Houston System. I just hope they will consider this thought the next time they hear a little ideological skirmishing on the grounds of the University of Houston Central Campus. Grounds Managers, the next time you find yourself between a rock and a hard place, you might try this sort of day dreaming. You will find you can soothe your nerves and create great solutions to all the world's problems, simultaneously and vengefully manipulating the bosses who challenged you to try the quagmire in the first place. As William H. Danforth of Ralston Purina Mills used to say, "I Dare You!"

## Time to Huddle

I doubt that I will ever forget Andrew Young's remarks as our first black Ambassador to the United Nations under President Carter. I could not believe my ears when he said he was not afraid of the Russians, earthquakes, or famine and that he saw the world only in black and white. He has quickly learned what I wanted to tell him then--all the world's actions cannot be adequately portrayed in black and white. Color receptors which absorb brown, yellow, red, blue, and green and the ability to understand other complexities of life like energy shortages are also necessary. Grounds Managers, I personally feel this is the great challenge

of our time. We have geared our amenity horticultural output and environmental grooming to the point that it has become an expected part of our way of life. I am here today to suggest that the mettle of our organizational efforts, as we know them today, will be tested to the hilt as we keep getting asked to do more and more with less and less of our dwindling natural resources. I wish I knew what to tell you to guard against the confusion and chaos which so vividly clouds the horizon and zigzags across the sky in my mind's eye when I envision the future. I understand now why many principals in the Bible's Old Testament are called "weeping prophets." High minority expectations and dwindling where-with-all will thunder loudly enough to deafen (benevolently, perhaps) most grounds managers who are able to stand the press of such times and continue at all. It does behoove each of us to look for own identities in life and work toward one for each employee who looks to us for all answers, regardless of our grip on the forces or controls involved. Commitment to excellence is still an exciting slogan. Knowing still leads to success and not knowing will lead to failure.

If it is important for us to get organized as individual grounds managers, it is equally important that we develop a voice for our industry so that our governoring officials can decide amenity horticulture's rightful place among the national interests clamoring for a fair share of the reel-turning, grass cutting energy resources so essential in our present-day operations. Earlier, I mentioned a football jersey that was worn all season and questioned something of the priorities afforded athletics and amenity horticultural operations. I grew up in a little place southeast of here called Hull-Daisetta, a booming oil town in the late thirties. During the first five years of public school, I never saw the Bobcats lose a game. They won 43 in a row, then played away from home during the only two they lost the next two years. Since I did not see these games, I grew half-way up before I realized the taste of defeat. I learned that lesson well a little later, though, and I also learned what a large part of the world seems oblivious to today. Oil wells go dry and boom towns can shrink into obscurity. I'd have a hard time today locating the oil field warehouse or the exact site of the home in which I lived at Gulf Oil Company's Headquarters in Daisetta just 25 years ago.

I do think we should press toward the mark of the prize of our own high calling at this hour whether it be organizing our own operations a little better for rougher seas ahead, urging the integration of two Distinct Universities while there is time to pave the way for affirmative action before Equal Opportunity runs afoul of lack of opportunity, or organizing the entire greens industry so that it can speak with one voice in the day ahead. Whether you are a proponent or opponent of big government, I think you'll have to agree, we as grounds managers are asked to handle many troublesome federal mandates emitting at such accelerating rates that disorganization rather than organization in our grounds management operations seem to be the order of the day. Many more energy-related mandates appear inevitable. While periods of disorganization are currently tolerated with a little more understanding, we all know our operations cannot continue to function in such a fashion. If we were playing foot-

ball so precariously, I would suggest that we call time while the clock still shows enough for a "huddle" where we might formulate a rational offense without depending on audibles at the line of scrimmage by our quarterbacking President, however brilliant he might appear before the terrific win-lose pressures unbearably increase as time runs out.

Position papers from this organization and all the other well-organized greens industries across this nation is a growing need. Standardization of groundskeeper identities through national certification efforts is a key to unification of the diverse, often confusing voices echoing throughout Capitol Hill from our various interests. The Professional Grounds Management Society, as mentioned earlier, is working on these organizational efforts and while the Texas Turfgrass Association is just as strong or perhaps even stronger than the National PGMS, the latter organization is zeroing in very hard on providing a "voice" for all the greens industry. While this national organizational effort may seem a far-cry from the organizational pep-talk you perhaps envisioned as you took your seat this afternoon, I hope you will give it some consideration as you work to promote professionalism in our field. I am old enough to realize that we belong to many different institutions brought into being by needs which have been filled for many years by organizations such as the Texas Turfgrass Association. I do feel the time has come for some meshing of the gears which turn to promote professional grounds management. As all of you know, even our notoriously independent farmers are considering the virtues of unification at this very moment.

If you have some ideas on how we can do this without diluting the identity of the autonomous groups which need a collective voice in Washington, I'd like to hear from you. I have committed myself for the next three years to addressing the goal of seeing that such ideas involving grounds management operations echo to Washington and back as clearly as members of this organization and all others in amenity horticultural divisions of the greens industry so desire. Thank you for this opportunity to outline the challenge of organizing our grounds management operations.

# COMPARATIVE SHADE ADAPTATION OF ST. AUGUSTINEGRASS AND TALL FESCUE AS AFFECTED BY CUTTING HEIGHTS AND NITROGEN REGIMES

BY

A. Almodares and J. B. Beard*

Maintaining a good quality turf under shade is a unique problem. In a 1966 state wide turfgrass survey in Pennsylvania, Boster (2) found that growing turfgrasses under shade was the number one turf problem. Beard (1) estimated 25 percent of existing turfs in the United States are maintained under some degree of shade. Turfs are grown in association with trees in such diverse areas as golf courses, parks, cemeteries, and home lawns.

## MATERIALS AND METHODS

Many cultural problems arise when turfgrasses are established, utilized, and maintained in shaded environments. The following study was initiated to (1) compare the adaptation of Kenwell tall fescue and Texas Common St. Augustinegrass under full sun versus post oak tree shade, (2) evaluate the effects of 1.5 and 3.0 inch cutting heights on the shade adaptation of the two species, and (3) evaluate the effects of 0.25, 0.50, 0.75, and 1.0 lb N/1000 $ft^2$/growing month on the shade adaptation of the two species.

Data taken during the experiments were leaf carbohydrate reserves, leaf orientation, root dry weights, shoot density courts, total nitrogen content of the leaves, turfgrass quality, verdure dry weights, vertical leaf extension rate, and turf cover estimates. In addition to the turfgrass shade responses, the specific microenvironments under both shade and non-shade conditions were monitored. Included were photosynthetically active radiation, relative humidity, temperature, and wind velocity measured at 12 noon.

The effects of shade, as influenced by mowing height and nitrogen nutritional level, on the shoot density and turfgrass quality over the growing season will be discussed in this presentation.

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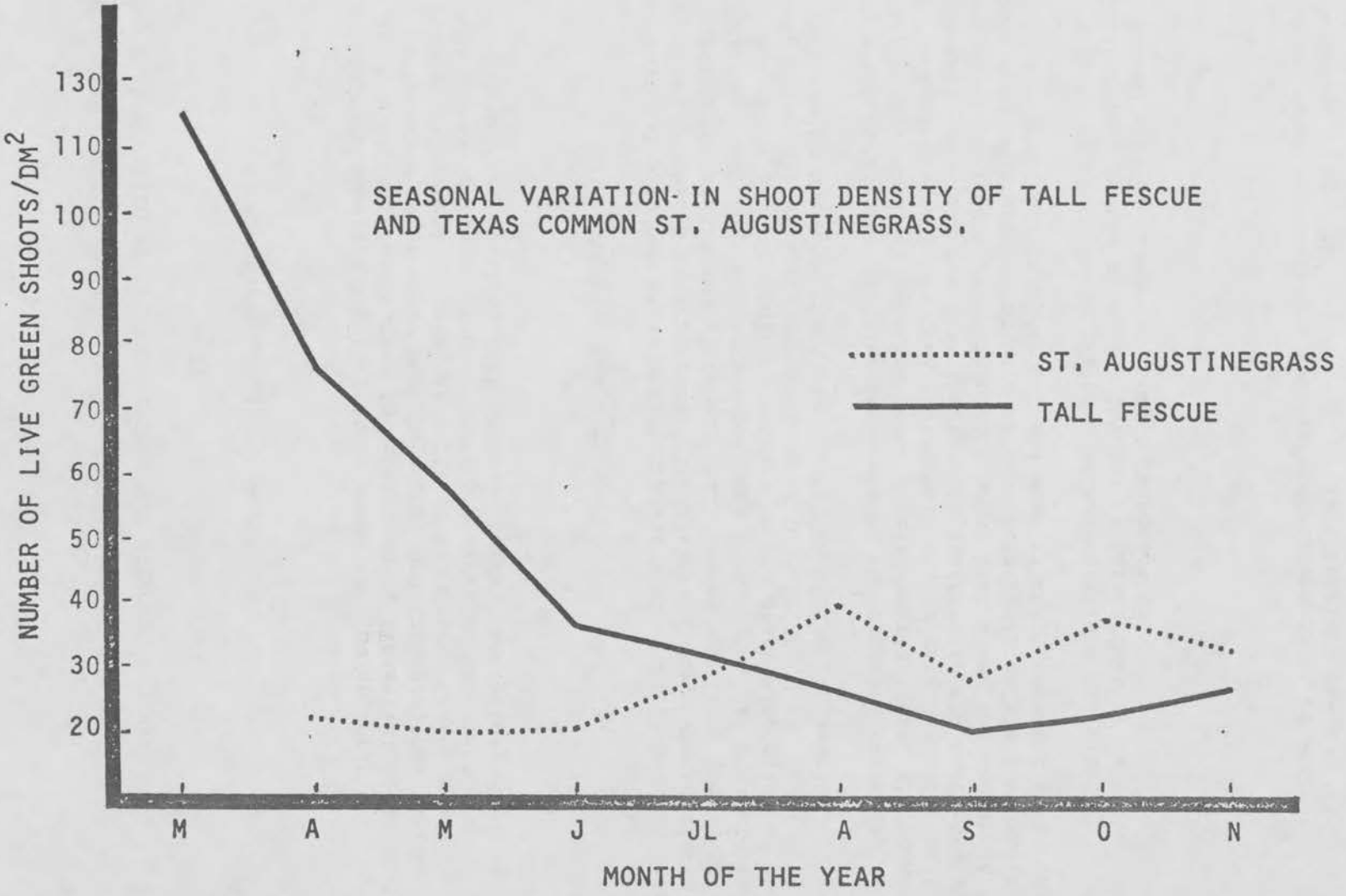
Figure 1.


SEASONAL VARIATION IN SHOOT DENSITY OF TALL FESCUE AND TEXAS COMMON ST. AUGUSTINEGRASS.
ST. AUGUSTINEGRASS
TALL FESCUE
NUMBER OF LIVE GREEN SHOOTS/DM2
130
110
100
90
80
70
60
50
40
30
20
M
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MONTH OF THE YEAR

## RESULTS

### A. Shoot Density Seasonal Variation

The seasonal variations in shoot density of Kenwell tall fescue and Texas Common St. Augustinegrass when grown under tree shade are shown on Figure 1. The shoot density of Kenwell tall fescue was reduced from 128 to 25 shoots per square decimeter from March to September. The density began to increase later in October. The shoot density was low, but acceptable for dense shade conditions, during the summer months from June to August but decreased later in November. Turfgrass quality showed a pattern similar to shoot density for both grasses, except for the Texas Common St. Augustinegrass receiving 0.25 lb. N/1000 $ft^2$/growing month. The latter had the lowest shoot density and turfgrass quality in July. This decline was attributed to seed head formation on those turfs maintained at a low nitrogen nutritional level.

Temperature had the greatest effect on seasonal variation in shoot density and turfgrass quality for both turfgrass. As temperature increased from June to October there was a decrease of shoot density and turfgrass quality of tall fescue, a cool season species, where as the shoot density and turfgrass quality of Texas Common St. Augustinegrass, a warm season species, increased during those months. In November the temperatures declined and there was a corresponding decrease of shoot density and turgrass quality of Texas Common St. Augustinegrass and an increase in the case of Kenwell tall fescue. These trends were similar for both full sunlight and post oak tree shade.

### B. Nitrogen Fertilization Effects

There were significantly different turfgrass responses between full sun and post oak tree shade in relation to nitrogen fertilization. The shoot density and turfgrass quality of both Kenwell tall fescue and Texas Common St. Augustinegrass when grown at four nitrogen fertility levels are shown in Table 1. In full sun, 0.75 and 1.0 pound nitrogen/1000 $ft^2$/growing month produced the highest shoot density and turfgrass quality for tall fescue and St. Augustinegrass, respectively. Under shaded conditions only 0.25 pounds N/1000 $ft^2$/growing month was required to produce adequate turfgrass quality and shoot density for both turfgrasses.

### C. Mowing Height Effects

Kenwell tall fescue and Texas Common St. Augustinegrass mowed at 3.0 inches had the highest turfgrass quality under both full sun and post oak tree shade. Shoot density was highest when the turfgrasses were mowed at 1.5 inches except for Kenwell tall fescue grown under full sunlight (Table 2).

D. Diseases

Limited disease activity has been observed during the study. Rust and Fusarium blight occurred on Kenwell tall fescue during the fall and summer, respectively. Tall fescue plots mowed at a 3-inch cutting height were more prone to rust than at 1.5 inches. Fusarium blight was more severe on turfgrasses maintained at a low cutting height.

Brown patch occurred on Texas Common St. Augustinegrass in the fall under both sun and tree shade. The disease was more severe at the 1.5 inch cutting height and at low to medium nitrogen nutritional levels.

## SUMMARY

These results indicate that: (1) There was a reduction in shoot density and turfgrass quality of tall fescue during the summer months followed by recovery in the fall; (2) The shoot density and turfgrass quality of Texas Common St. Augustinegrass increased during the summer under tree shade at all nitrogen levels and in the full sun at the high nitrogen levels. The decrease in full sun at low nitrogen levels was attributed to the increase in seed head formation; (3) Texas Common St. Augustinegrass and tall fescue mowed at either 1.5 or 3 inches under tree shade had adequate shoot density and turfgrass quality at 0.25 pound nitrogen/1000 $ft^2$/growing month; (4) Shoot density and turfgrass quality of Texas Common St. Augustinegrass and tall fescue mowed at 1.5 and 3.0 inches under full sunlight were highest at 0.75 and 1.0 pound nitrogen/1000 $ft^2$/growing month, respectively.

Table 1. The seasonal mean shoot density and turfgrass quality of Kenwell tall fescue and Texas Common St. Augustinegrass under full sun and tree shade conditions as influenced by four nitrogen nutritional levels when mowed at 1.5 inches. College Station, Texas, 1977.

| Light Level | Nitrogen Level* | Kenwell Tall Fescue | | Texas Common St. Augustinegrass | |
|---|---|---|---|---|---|
| | | Shoot** Density | Turfgrass Quality*** | Shoot Density | Turfgrass Quality |
| Full Sun | 0.25 | 36 | 6.2 | 35 | 6.0 |
| | 0.5 | 63 | 6.5 | 48 | 8.0 |
| | 0.75 | 67 | 7.0 | - | - |
| | 1.0 | 65 | 7.0 | 51 | 9.1 |
| Post Oak | 0.25 | 76 | 7.7 | 40 | 8.7 |
| Tree Shade | 0.5 | 70 | 7.3 | 38 | 8.7 |
| | 0.75 | 84 | 7.8 | - | - |
| | 1.0 | 72 | 8.0 | 43 | 8.7 |

* Pounds nitrogen/1,000 sq. ft./growing month.

** Number of shoots/$dm^2$.

*** Visual quality estimate (9=best to 1=poorest).

Table 2. The seasonal mean shoot density and turfgrass quality of Kenwell tall fescue and Texas Common St. Augustinegrass as influenced by two mowing heights when grown in full sun and tree shade. College Station, Texas, 1977.

| Light Level | Turfgrass Measurement | Tall Fescue | | St. Augustinegrass | |
|---|---|---|---|---|---|
| | | 1.5 in. | 3.0 in. | 1.5 in. | 3.0 in. |
| Full Sun | Shoot Density* | 67 | 78 | 51 | 45 |
| | Turfgrass Quality** | 7.0 | 8.7 | 9.0 | 9.2 |
| Post Oak Tree Shade | Shoot Density* | 84 | 58 | 43.0 | 26.0 |
| | Turfgrass Quality** | 7.8 | 8.2 | 8.7 | 8.7 |

* Number of shoots/$dm^2$.

** Visual quality estimate (9=best to 1=poorest).

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# 1977 WINTER OVERSEEDING PERFORMANCE ON DORMANT TURFS

by

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This progress report represents the second in a series of studies to be conducted over a 4-year period. The objective is to characterize the available range of species, cultivars, and polystands in terms of their performance when overseeded onto winter dormant bermudagrass (Cynodon (L.) Pers.). While PR-3439 reported results for a single location at College Station, this year's report includes evaluations at both College Station and Houston, Texas.

## MATERIALS & METHODS

College Station Site. This winter overseeding study was conducted on a mature bermudagrass turf located on the Texas A&M University Field laboratory plots. The site and conditions were basically the same as that reported for the 1976 study in PR-3439. Cultural practices utilized on the experimental area during the summer prior to winter overseeding included: daily mowing at 0.25 inch; an application of one pound nitrogen/1000 sq. ft./growing month; applications of phosphorus and potassium as needed based on soil tests; irrigation as needed to prevent wilt; and an occasional application of diazinon as needed to control insect pests which threatened serious turf injury. No preemergence herbicide was used. The plot size was 5X7 feet in a randomized block design of 3 replication. Two of the replications were on Tifgreen bermudagrass while one replication was on Tifdwarf bermudagrass.

The overseeding procedure can be summarized as follows: On October 15, 1976, the bermudagrass turf was vertically mowed in several directions with the cuttings removed by means of a mower with catcher. One pound of actual nitrogen per 1000 sq. ft. was applied on October 16 in the form of ammonium nitrate. Mowing ceased on October 27. The fungicide captan was applied at the recommended label rate on October 28. The actual seeding was accomplished on October 30, utilizing the following procedure. Individual plot boundaries were delineated with string. The amount of seed required for a single plot was placed in a 2 foot gravity spreader adjusted to a setting which required a minimum of 3 passes over the plot area before all the seed was uniformly distributed within the

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KEYWORDS: turfgrass/cultivars/Kentucky bluegrasses (Poa pratensis L.)/chewings fescues (Festuca rubra L.)/perennial ryegrasses (Lolium perenne L.)/bermudagrass/winter overseeding.

plot. Following seeding the entire area was topdressed at a rate of 0.4 cubic yards per 1000 sq. ft. by means of a mechanical topdresser. The plot area was then kept constantly moist for a 14-day period by means of light, frequent applications as necessitated by the evapotransporation rate. No fungicides or insecticides were applied following seeding and no visual signs of disease or insect damage were observed following emergence. Mowing was reinitiated on November 7 at 5/16 inch with the cutting height being lowered to 1/4 inch two weeks later.

Cultural practices utilized on the overseeded turf during the winter period included mowing 3 times per week at 1/4 inch with clippings removed. Fertilization was at bi-weekly intervals at rates of 0.5 and 1.0 lbs. actual nitrogen per 1000 sq. ft. on a split plot basis of 3 and 4 foot widths, respectively.

Irrigation was applied as needed to prevent wilt. No fungicides or insecticides were applied during the winter overseeding period. The plots were visually rated for turfgrass quality on a scale from 9-best to 0-poorest. Fall establishment ratings were taken on November 8, 9, 11, 12, 15, 16 and 24. Subsequently, the plots were rated weekly until the overseeded grasses ceased to be a significant component of the turf during the spring transition. No vertical mowing was practiced during the spring period to impair the cool season overseeded grasses and thus enhance bermudagrass transition.

Houston Site. This companion study to the College Station site just described was conducted on a mature Tifdwarf bermudagrass turf located at the Houston Country Club in Houston, Texas.* The site selected had been maintained at a somewhat higher cutting height. Thus during the late summer of 1976, the cutting height was gradually reduced to 3/8 inch. During the summer prior to overseeding the area had been fertilized in the spring and the fall at a rate of 1 pound nitrogen per 1000 sq. ft. with Milorganite as the nitrogen source; plus a fall application of 1 pound K per 1000 sq. ft. as potassium sulfate. No preemergence herbicide had been applied. Irrigation was applied as needed to prevent wilt. The plot size utilized was 6X8 feet arranged in a randomized block design of 3 replications.

The overseeding procedure can be summarized as follows: On September 1 and 3 1976, the area was vertically mowed in several directions with the objective of mechanically controlling the excessive thatch accumulation which had occurred. Mowing ceased on October 15. The overseeding was accomplished on October 18 using the same techniques as described for the

*The cooperation of Mr. L. W. Dubose, Jr. is acknowledged in the planting and winter maintenance of the study area.

College Station site. After all plots were seeded the entire area was topdressed at a rate of 0.6 cubic yards per 1000 sq. ft. utilizing a mechanical topdresser. This somewhat higher rate was used because of the greater thatch remaining. The plot area was kept constantly moist for a 14 day period by irrigation as needed. No insecticides or fungicides were applied during the establishment period, since there was no visual evidence of pest injury. Mowing was reinitiated on October 25 at a cutting height of 3/8 inch with clippings being removed.

The experimental area was mowed throughout most of the winter period at a height of 3/8 inch. The cutting height of one replication was lowered to 3/16 inch in March. One and one half pounds of nitrogen per 1000 sq. ft. as Milorganite was applied on October 28, November 30, and December 27, 1976, and on February 7 and April 14, 1977. In addition, a 18-24-6 analysis fertilizer was applied at a rate equivalent to 1/2 lb. nitrogen per 1000 sq. ft. on November 12, 1976. An application of potassium sulfate (0-0-50) was made at a rate of 4 lbs. K per 1000 square feet on January 20, 1977. Dolomitic limestone was applied at 20 lbs. per 1000 square feet on December 27, and 30 lbs. per 1000 square feet on December 29. A preventive fungicide program was applied involving applications of Fore at five ounces per 1000 square feet on October 29, November 12, and November 26, 1976. This was followed by an application of chloroneb on April 9 at 4 ounces/1000 square feet. Irrigation was applied throughout the winter period as needed to prevent visual wilt.

The treatments were visually rated for turfgrass quality employing a scale from 9-best to 0-poorest. The study areas were rated on October 23 and 28 and November 3 and 12, 1976, during the establishment period. Subsequently, ratings were made at two week intervals throughout the remainder of the winter period and the spring transition.

## RESULTS AND DISCUSSION

Winter conditions during 1976 were exceptionally cold as shown by the average monthly temperature compared to the long term mean (Table 1). Onset of the cold period started quite early in October which caused problems for overseedings which were not planted typically early. This is in extreme contrast to the 1975-76 winter which was quite warm with bermudagrass never entering complete dormancy.

### College Station Site

The winter performance of most of the turf type perennial ryegrass cultivars was good with no significant differences among the top thirteen (Table 2). No visible disease problems were evident during the 1976-77 winter. Citation was the top ranked cultivar during the winter of 1977 as was the case in 1976, even though the winter conditions were strikingly different between the two years. Other perennial ryegrass cultivars

performing quite well in both years included Manhattan, Pennfine, Derby, and Yorktown. Fall establishment of the perennial ryegrass cultivars was good. NK-100 and Pelo were particularly rapid in establishment. There were no practical differences in spring transition.

Among the eleven non-ryegrass cultivars evaluated, Sabre rough bluegrass and Dawson chewings fescue ranked superior in winter overseeding performance and comparable to most of the improved perennial ryegrass cultivars (Table 3). The results confirm the observations made during the 1975-76 winter overseeding experiment. However, the relative performance of these two cultivars compared to the improved turf type perennial ryegrasses was not as good as in the previous winter. That is to say, Sabre rough bluegrass and Dawson chewings fescue were favored by the warm, dry winter conditions while the turf type perennial ryegrasses were better adapted to a cold, wet winter. Jamestown chewings fescue performed much better during 1977 than 1976. Others ranking comparable to Jamestown in performance include Wintergreen chewings fescue, Pennlawn red fescue, and Kensington chewings fescue. Penncross creeping bentgrass ranked quite low. This was partially attributed to the very cold early fall conditions which accentuated the inherently slow establishment characteristics of the creeping bentgrasses. Fall establishment of the 11 non-ryegrass cultivars was generally poor compared to the perennial ryegrass except for Dawson and Wintergreen chewings fescue. Spring transition of the 11 non-ryegrass cultivars was inferior to the perennial ryegrasses except for Dawson chewings fescue.

Winter performance among the thirteen polystands was quite comparable (Table 4). The same was observed for fall establishment and spring transition, with the exception of fall establishment of Medalist-300 and OS-603 Blend. A mottled coloration was evident during the spring transition of the 80% Derby + 20% Sabre polystand.

Houston Site

There were no practical differences in winter performance among the more recently released turf type perennial ryegrass cultivars at Houston as was the case in the College Station experiment (Table 6). Fall establishment of the turf type perennial ryegrasses was generally quite good, except for Linn perennial ryegrass. There were no significant differences in the spring transition performance.

Comparative rankings among the top five non-ryegrass cultivars were the same at the Houston site as at College Station. Sabre rough bluegrass ranked higher than the perennial ryegrasses. Performing comparable to the turf type perennial ryegrasses was Dawson chewings fescue with Jamestown chewings fescue, Wintergreen chewings fescue, and Pennlawn red fescue ranking slightly lower. Penncross creeping bentgrass ranked considerably higher at the Houston site than at College Station, which could be attributed to the earlier planting date and somewhat warmer winter growing conditions. Sabre rough bluegrass was decidely superior to "Denmark" rough bluegrass. The bentgrass cultivars tended to persist longer in the spring than the remainder of the species evaluated, which

could be objectionable in certain types of cultural programs. Fall establishment of the fourteen non-ryegrass cultivars was decidedly inferior to the turf type perennial ryegrass cultivars with the exception of Dawson chewings fescue which also performed similarly at the College Station site. Wintergreen and Jamestown chewings fescues also were somewhat improved. Spring transition was also inferior to the perennial ryegrasses except for Penncross and Seaside creeping bentgrasses plus Sabre rough bluegrass and Dawson chewings fescue.

Winter performance among the fourteen polystands was not significantly different as was the case at the College Station site (Table7). Similarly, no major differences were observed in terms of fall establishment, although the perennial ryegrass blends and polystands containing high percentages of the turf type perennial ryegrass cultivars did rank slightly higher. There were no significant differences in spring transition as was the case at the College Station site.

## SUMMARY

Based on two years results, the general trend shows minimal differences among the improved turf type perennial ryegrass cultivars in terms of overall turfgrass quality as an overseeded turf, where no disease problems have occurred. The perennial ryegrass cultivars ranked superior to the chewings fescue cultivars during a cold, wet winter, while Dawson chewings fescue tended to perform best during a warm, dry winter. The creeping bentgrasses have generally ranked inferior due to an extremely poor fall and early winter establishment. For those sites having spring usage which requires persistence of the overseeding stand, the inclusion of creeping bentgrass in the polystand could prove beneficial.

Table 1. Summary of monthly temperature and precipitation patterns for College Station* during the period of the winter overseeding study.

| | Temperature (mean monthly F) | | | Precipitation (inches) | | |
|---|---|---|---|---|---|---|
| | 1975-76 | 1976-77 | 1933-62 mean | 1975-76 | 1976-77 | 1933-62 mean |
| Sept. | 75.0 | 77.0 | 79.4 | 4.11 | 3.51 | 3.30 |
| Oct. | 69.6 | 60.2 | 70.7 | 3.88 | 5.62 | 2.84 |
| Nov. | 59.9 | 51.2 | 59.1 | 1.01 | 3.33 | 2.31 |
| Dec. | 52.1 | 48.1 | 53.6 | 1.11 | 4.16 | 3.50 |
| Jan. | 49.4 | 41.1 | 51.1 | 1.16 | 1.92 | 2.86 |
| Feb. | 60.8 | 53.7 | 54.6 | 1.17 | 3.30 | 2.93 |
| March | 61.6 | 60.9 | 61.6 | 3.56 | 1.86 | 2.67 |
| April | 67.8 | 68.0 | 68.2 | 6.05 | 7.66 | 3.73 |
| May | 70.6 | 75.7 | 75.6 | 5.94 | 0.78 | 4.70 |

*Measured at nearby Easterwood Airport, College Station, Texas

Table 2. An evaluation of seventeen perennial ryegrass cultivars for winter overseeding of bermudagrass greens, 1976-77, College Station, Texas

| Ryegrass cultivar | Winter performance[1] (16 ratings) | Fall establishment[2] (8 ratings) | Spring transition[3] (8 ratings) | Seeding rate (lbs/1000 ft$^2$) |
|---|---|---|---|---|
| Citation | 7.4 | 2.9 bcd[5] | 7.4 a[5] | 40 |
| K5-90 | 7.4 | 2.7 cde | 7.3 ab | 45 |
| Pennfine | 7.4 | 2.9 bcde | 7.4 a | 45 |
| Derby | 7.2 | 2.9 bcd | 7.3 ab | 40 |
| Manhattan | 7.2 | 3.1 bc | 7.2 ab | 40 |
| Yorktown | 7.2 | 2.8 bcde | 7.4 a | 40 |
| Loretta | 7.1 | 3.2 b | 7.1 ab | 40 |
| Omega | 7.0 | 3.0 bcd | 7.4 a | 40 |
| Caravelle | 7.0 | 2.5 e | 7.3 ab | 40 |
| Birdie | 7.0 | 2.8 bcde | 7.3 ab | 40 |
| Yorktown II | 7.0 | 3.1 bc | 7.4 a | 40 |
| K5-92 | 7.0 | 2.8 bcde | 7.3 ab | 45 |
| Diplomat | 7.0 | 2.6 de | 7.3 ab | 40 |
| S-321 | 6.9 | 3.1 bc | 7.2 ab | 45 |
| Pelo | 6.8 | 3.7 a | 6.9 b | 45 |
| NK-200 | 6.8 | 2.5 e | 7.2 ab | 45 |
| NK-100 | 6.6 | 3.8 a | 7.2 ab | 45 |

[1]Visual rating of 9-best and 0-poorest; December 4, 1976 to March 28, 1977.

[2]Visual rating of 9-best and 0-poorest; November 8 to November 24, 1976.

[3]Visual rating of 9-best and 0-poorest; April 4 to May 26, 1977.

[4]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 3. An evaluation of eleven non-ryegrass cultivars for winter overseeding of bermudagrass greens, 1976-77, College Station, Texas.

| Cultivar and species | Winter performance[1] (16 ratings) | Fall establishment[2] (8 ratings) | Spring transition[3] (8 ratings) | Seeding rate (lbs/1000 ft$^2$) |
|---|---|---|---|---|
| Sabre rough bluegrass | 7.3 [4] | 2.0 c[5] | 6.4 bc[5] | 12 |
| Dawson chewings fescue | 7.1 | 3.3 a | 7.2 a | 40 |
| Jamestown chewings fescue | 6.2 | 2.0 c | 6.4 bc | 30 |
| Wintergreen chewings fescue | 6.2 | 2.5 b | 6.4 bc | 40 |
| Pennlawn red fescue | 6.0 | 1.1 de | 6.5 bc | 40 |
| Kensington chewings fescue | 5.8 | 0.9 ef | 6.6 b | 30 |
| Centurian chewings fescue | 5.3 | 1.3 d | 5.7 d | 40 |
| Golfrood chewings fescue | 5.0 | 0.6 f | 6.6 b | 40 |
| Denmark (common) rough bluegrass | 5.0 | 0.7 f | 6.2 c | 12 |
| Fortress red fescue | 4.9 | 1.9 c | 6.4 bc | 30 |
| Penncross creeping bentgrass | 3.9 | 0.6 f | 6.7 b | 3 |

[1]Visual rating of 9-best and 0-poorest: December 4, 1976 to March 28, 1977.

[2]Visual rating of 9-best and 0-poorest: November 8 to November 24, 1976.

[3]Visual rating of 9-best and 0-poorest; April 4 to May 26, 1977.

[4]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 4. An evaluation of thirteen polystands for winter overseeding of bermudagrass greens, 1976-77, College Station, Texas.

| Seed mixture | Winter performance[1] (16 ratings) | [4] | Fall establishment[2] (8 ratings) | Spring transition[3] (8 ratings) | Seeding rate (lbs/1000 ft$^2$) |
|---|---|---|---|---|---|
| CBS Blend | 7.3 | | 2.9 ab[5] | 7.4 ab[5] | 40 |
| 80% Derby & 20% Sabre | 7.2 | | 2.2 ef | 6.9 b | 20 |
| Dixiegreen | 7.2 | | 2.4 cde | 7.3 ab | 40 |
| Medalist 400 | 7.2 | | 2.7 abcd | 7.4 a | 38 |
| Wintergreen I | 7.2 | | 3.2 a | 7.2 ab | 35 |
| OS-601 (blend) | 7.1 | | 2.9 abc | 7.2 ab | 35 |
| 60% Yorktown II & 40% Jamestown | 7.1 | | 2.7 abcd | 7.3 ab | 35 |
| Wintergreen III | 7.1 | | 2.5 bcde | 7.4 a | 35 |
| Medalist 200 | 7.0 | | 2.9 abcd | 7.3 ab | 32 |
| 60% Diplomat & 40% Jamestown | 7.0 | | 2.9 abcd | 7.2 ab | 35 |
| 40% Jamestown & 60% Yorktown | 7.0 | | 2.4 def | 7.3 ab | 35 |
| OS-603 (blend) | 6.7 | | 2.0 f | 7.3 ab | 35 |
| Medalist 300 | 6.7 | | 2.0 f | 7.2 ab | 29 |

[1]Visual rating of 9-best and 0-poorest; December 4, 1976 to March 28, 1977.

[2]Visual rating of 9-best and 0-poorest; November 8 to November 24, 1976.

[3]Visual rating of 9-best and 0-poorest; April 4 to May 26, 1977.

[4]Values joined by the same line are not significantly different at th 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 5. An evaluation of twenty perennial ryegrass cultivars for winter overseeding of bermudagrass greens, 1976-77, Houston, Texas

| Ryegrass cultivar | Winter performance[1] (8 ratings) | | Fall establishment[2] (4 ratings) | Spring transition[3] (4 ratings) | Seeding rate (lbs/1000 ft$^2$) |
|---|---|---|---|---|---|
| K5-90 | 7.8 | 4 | 3.5 fgh[5] | 7.4 a[5] | 45 |
| Pennfine | 7.7 | | 3.4 gh | 7.4 a | 45 |
| Derby | 7.7 | | 3.9 cdefgh | 7.5 a | 40 |
| Caravelle | 7.7 | | 3.4 gh | 7.4 a | 40 |
| Citation | 7.7 | | 4.5 bcd | 7.4 a | 40 |
| Diplomat | 7.6 | | 3.7 efgh | 7.5 a | 40 |
| Manhattan | 7.6 | | 4.4 bcde | 7.3 a | 40 |
| Yorktown II | 7.5 | | 4.0 bcdefg | 7.4 a | 40 |
| Yorktown | 7.5 | | 3.6 fgh | 7.4 a | 40 |
| S-321 | 7.5 | | 4.2 bcdef | 7.3 a | 45 |
| Birdie | 7.5 | | 3.9 defgh | 7.5 a | 40 |
| NK-200 | 7.5 | | 3.3 hi | 7.3 a | 45 |
| Pelo | 7.4 | | 4.6 bc | 7.4 a | 45 |
| Omega | 7.4 | | 3.8 defgh | 7.5 a | 40 |
| K5-92 | 7.4 | | 3.4 gh | 7.3 a | 45 |
| Loretta | 7.4 | | 4.7 b | 7.4 a | 40 |
| NK-100 | 7.3 | | 5.4 a | 7.0 a | 45 |
| Linn | 7.2 | | 2.6 i | 7.3 a | 40 |
| Norlea | 7.1 | | 3.5 fgh | 7.2 a | 40 |
| Lamora | 7.0 | | 3.7 efgh | 7.1 a | 40 |

[1]Visual rating of 9-best and 0-poorest; November 23, 1976 to March 16, 1977.

[2]Visual rating of 9-best and 0-poorest; October 23 to November 12, 1976.

[3]Visual rating of 9-best and 0-poorest; April 3 to May 28, 1977.

[4]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 6. An evaluation of fourteen non-ryegrass cultivars for winter overseeding of bermudagrass greens, 1976-77, Houston, Texas.

| Cultivar and Species | Winter performance[1] (8 ratings) | Fall establishment[2] (4 ratings) | Spring transition[3] (5 ratings) | Seeding rate (lbs./1000 ft$^2$) |
|---|---|---|---|---|
| Sabre rough bluegrass | 7.9 [4] | 2.3 cd[5] | 6.9 a[5] | 12 |
| Dawson chewings fescue | 7.4 | 3.7 a | 6.6 ab | 40 |
| Jamestown chewings fescue | 6.8 | 2.9 bc | 6.3 bc | 30 |
| Wintergreen chewings fescue | 6.6 | 3.0 ab | 5.7 cd | 40 |
| Pennlawn red fescue | 6.5 | 2.2 cd | 6.0 cd | 40 |
| Seaside creeping bentgrass | 6.4 | 1.1 ef | 7.2 a | 3 |
| Penncross creeping bentgrass | 6.2 | 0.8 f | 7.1 a | 3 |
| Centurian chewings fescue | 6.1 | 2.4 bcd | 4.8 e | 40 |
| Emerald creeping bentgrass | 6.0 | 0.8 f | 6.8 ab | 3 |
| Kensington chewings fescue | 5.9 | 1.8 de | 5.5 d | 30 |
| Denmark (common) rough bluegrass | 5.6 | 0.7 f | 6.8 ab | 12 |
| Fortress red fescue | 5.6 | 2.7 bc | 5.7 cd | 30 |
| Golfrood chewings fescue | 5.4 | 1.1 ef | 5.7 cd | 40 |
| Atlanta chewings fescue | 5.3 | 1.0 f | 5.6 d | 30 |

[1]Visual rating of 9-best and 0-poorest; November 23, 1976 to March 16, 1977.

[2]Visual rating of 9-best and 0-poorest; October 23 to November 12, 1976.

[3]Visual rating of 9-best and 0-poorest; April 3 to May 28, 1977.

[4]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

Table 7. An evaluation of fourteen polystands for winter overseeding of bermudagrass greens, 1976-77, Houston, Texas.

| Seed mixture | Winter performance[1] (8 ratings) | | Fall establishment[2] (4 ratings) | Spring transition[3] (5 ratings) | Seeding rate (lbs./1000 ft$^2$) |
|---|---|---|---|---|---|
| Dixiegreen | 7.9 | [4] | 3.4 bcd[5] | 7.6 a[5] | 40 |
| Medalist 200 | 7.7 | | 3.4 bcd | 7.4a | 32 |
| OS-601 (blend) | 7.7 | | 4.4 a | 7.5 a | 35 |
| Medalist 400 | 7.7 | | 3.9 ab | 7.4 a | 38 |
| Medalist 5 (blend) | 7.7 | | 3.7 abc | 7.5 a | 45 |
| CBS Blend | 7.6 | | 3.9 ab | 7.4 a | 40 |
| Wintergreen III | 7.6 | | 3.4 bcd | 7.5 a | 35 |
| Wintergreen I | 7.5 | | 3.4 bcd | 7.6 a | 35 |
| 60% Yorktown II & 40% Jamestown | 7.5 | | 3.8 ab | 7.4 a | 35 |
| OS-603 (blend) | 7.5 | | 3.0 cde | 7.3 a | 35 |
| 80% Derby & 20% Sabre | 7.5 | | 2.7 de | 7.3 a | 20 |
| Medalist 300 | 7.4 | | 2.5 c | 7.5 a | 29 |
| 60% Diplomat & 40% Jamestown | 7.4 | | 3.3 bcd | 7.3 a | 35 |
| 40% Jamestown & 60% Yorktown | 7.4 | | 2.9 de | 7.3 a | 35 |

[1]Visual rating of 9-best and 0-poorest; November 23, 1976 to March 16, 1977.

[2]Visual rating of 9-best and 0-poorest; October 23 to November 12, 1976.

[3]Visual rating of 9-best and 0-poorest; April 3 to May 28, 1977.

[4]Values joined by the same line are not significantly different at the 5% level for Duncan's Multiple Range Test.

[5]Values with the same letter are not significantly different at the 5% level for Duncan's Multiple Range Test.

# EFFECT OF FUNGICIDES IN REDUCING FUNGAL SPORE POPULATION ON TURFGRASS THATCH

by

Phillip F. Colbaugh*

Evaluations of turf fungicides are based on the control of turfgrass diseases. Following application of a specific fungicide formulation, the progress of disease symptoms is halted or disease symptoms may not appear based upon the timing of fungicide application. This approach to the evaluation of turf fungicides has been very successful for golf course superintendents over the years. Through fungicide testing programs we have accumulated a good deal of information on the control of disease expression on turf, although, this information may or may not relate to the destruction of spores of target pathogens which cause turf diseases.

Most diseases of turfgrasses are caused by fungal pathogens which are active only during certain periods of the year. The majority of these fungal pathogens are fungi that live as saprophytes on dead or dying plant parts in the thatch layer which surrounds the turfgrass plant. When environmental conditions favor the disease these fungi can become aggressive pathogens on the living plant and we call these pathogens faculative fungal parasites.

Spores produced by fungal pathogens on turf not only spread and initiate diseases but also insure long-term survival of the pathogens during environmental periods not favoring disease activity. Even a small sample of dead or dying plant parts which surround the turfgrass plant contain thousands of survival spores of potential pathogens of turf. Spores and sclerotia of fungal pathogens have been shown to exist for long periods in soil or on plant debris. For example, some fungal spores can survive more than 10 years in soil and appear to be very difficult to destroy.

In spite of our knowledge of disease suppression using fungicides, we know nothing of the ability of fungicides to kill dormant spores which represent the future potential for disease. The following study was conducted to determine the ability of turf fungicides to eradicate dormant spores of Heminthosporium spp. on tall fescuegrass thatch.

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Tall fescue (var. alta) turf which was maintained at a three inch clipping height and received .5 lb/N/month during the summer months was used in the experiment. Thatch or crop debris, which consisted of dead or dying plant parts, was collected from the turf plot in July using a hand rake. The crop debris was uniformly dusted with spores of Helminthosporium sorokinianum before fungicides were each applied at rates of 4, 8 and 16 oz. The volume of fungicide suspension used to treat 40g samples of the infested crop debris was 10.3 ml/sample, which was calculated to be equivalent to 10gal/1000ft$^2$. Crop debris samples were incubated for 48 hr at 27C following application of test fungicides. Following incubation of treatment samples, spores were washed from the crop debris by shaking in water and collected on whatman filter paper discs. The spores were washed by rinsing the filter paper with water five times then placed in petri dishes containing fresh water amended with 2% yeast extract in order to stimulate germination. Following incubation of spores in the germination medium for 24 hr at 24C the percentage germination of spores was determined by microscopic observation. The data from spore germination studies is summarized in Table 1 and is expressed as percentage kill at 2,000 ppm active ingredient of each fungicide tested.

RESULTS

Fungicides considered most effective in killing dormant spores of H sorokinianum were two experimental compounds, MF-598 (Mallinskrodt Chemical Works), El-222 (Elanco Products) and carbamate fungicides Tersan LSR, Fore, and Manzate 200 (Table 1). Daconil 2787 was considered effective although higher rates were required when compared to carbamate fungicides. Other fungicides used in the study were less effective in killing dormant spores of the fungus.

The effectiveness of fungicides in eradicating survival spores of turfgrass pathogens is considered important for reducing the potential for disease activity. The carbamate turf fungicides such as Tersan LSR and Fore, which were most effective in reducing viability of Helminthosporium spores, are generally recommended for control of diseases incited by this pathogen. Other fungicides considered effective for controlling Helminthosporium diseases of turf such as Daconil 2787, Dyrene or Captan required higher rates than carbamate fungicides to reduce populations of viable spores. Although these results are laboratory data, carbamate fungicides used in this study have potential for eradicating dormant spores of Helminthosporium spp. on the turf crop debris under field conditions.

Table 1.

Percent kill of conidia of H. sorokinianum on tall fescue thatch 48 hours following treatment with various fungicides.

| Fungicide | Formulation | Rate Recommended on Turf/1000 $ft^2$ | % Kill @2,000 ppm a.i. |
|---|---|---|---|
| 1. MF-598 | 75 W.P. | 4-6 oz. | 65 (4.8 oz.) |
| 2. EL-222 | 12.5 E.C. | .75-16 fl.oz. | 65 (16 fl.oz.) |
| 3. Tersan LSR | 80 W.P. | 3-8 oz. | 63 (2.7 oz.) |
| 4. Fore | 80 W.P. | 3-8 oz. | 62 (2.7 oz.) |
| 5. Manzate 200 | 80 W.P. | 3-8 oz. | 61 (2.7 oz.) |
| 6. Daconil 2787 | 75 W.P. | 2-8 oz. | 49 (3 oz.) |
| 7. Turfcide | 24 E.C. | 32 fl.oz. | 37 (9 fl. oz.) |
| 8. Terraclor | 10 G | 120 oz. | 30 (8 oz.) |
| 9. Formaturf | 37 E.C. | 5-10 fl.oz | 23 (6.4 fl.oz.) |
| 10. Dyrene | 50 W.P. | 4-6 oz. | 22 (4.4 oz.) |
| 11. Fungo 50 | 50 W.P. | 2-8 oz. | 22 (4 oz.) |
| 12. R.P. 26019 | 50 W.P. | 1-4 oz. | 20 (4.4 oz.) |
| 13. BAS 35204F | 50 W.P. | .37 oz. | 19 (4.8 oz.) |
| 14. CGA-48988 | 50 W.P. | 1-2 oz. | 18 (4.8 oz.) |
| 15. GA-1105 | 21.5 W.P. | .9-3.8 oz. | 17(10.4 oz.) |
| 16. Captan | 50 W.P. | 4-6 oz. | 15 (4.8 oz.) |
| 17. Calo-Clor | 90 W.P. | 3 oz. | 13 (2.4 oz.) |
| 18. Benomyl | 50 W.P. | .5-8 oz. | 13 (4.8 oz.) |
| 19. Bay Meb 6447 | 50 W.P. | 2-8 oz. | 9 (4.8 oz.) |

# EFFECT AND TREATMENTS OF PETROLEUM SPILLS ON BERMUDAGRASS TURF

by

D. Johns and J. B. Beard*

Recent trends to increasingly sophisticated mechanization on turf equipment has resulted in petroleum spills being a greater problem on intensively maintained turf areas, especially golf greens. Procedures for alleviating these stresses and enhancing recovery of the turf have not been investigated. A study was conducted during the summer of 1977 to: (1) determine the specific turfgrass symptoms associated with various types of petroleum spills, (2) assess the comparative rates of turfgrass recovery following petroleum spills, and (3) evaluate potential corrective treatments for their effectiveness in counteracting petroleum spill effects on turf and enhancing turf recovery.

## Treatments

Five petroleum products commonly used in turfgrass maintenance equipment were selected as the spill treatments. Included were gasoline, motor oil, hydraulic fluid, brake fluid, and grease. The grease was applied to an area of 0.4 square feet while the other four were sprayed over areas of 4 square feet. The five materials were at ambient air temperature when applied. A list of the petroleum products and the rates at which they were applied is shown in Table 1. The petroleum products were applied to Tifgreen bermudagrass which had been mowed twice weekly at a cutting height of 1 inch with clippings returned. The bermudagrass was irrigated daily (1/4 inch water/day) and received 1 lb N/1000 sq. ft./month over the growing season.

Table 1. Summary of petroleum products applied to Tifgreen bermudagrass.

| Petroleum | Rates of Application |
|---|---|
| Gasoline (leaded) | 0.25 pints/sq. ft. |
| Motor Oil (30 SEA) | 0.25 pints/sq. ft. |
| Hydraulic fluid | 0.25 pints/sq. ft. |
| Brake fluid | 0.25 pints/sq. ft. |
| Grease | 2.0 oz/sq. ft. |

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Three corrective treatments and an untreated check were superimposed over the five petroleum spills. The check included a thorough drenching of the spill area with water. The corrective treatments were applied within 20 minutes following the petroleum application. A list of the corrective treatments and their rates of application is shown in Table 2. All treatments were replicated three times.

Table 2. Corrective treatments applied to petroleum spills on Tifgreen Bermudagrass.

| Corrective Treatment | Rate of Application |
|---|---|
| Calcined clay fines (mm) | 2.1 oz/sq. ft. |
| Activated charcoal | 0.2 oz/sq. ft. |
| Detergent (anionic and non-ionic granules) | 0.7 oz/sq. ft. |

## Injury Symptoms

Since the specific injury symptoms associated with each of the five petroleum products were described in the Turfgrass Research Report: Texas A&M Turfgrass Field Day, June 1977,* they will be only briefly summarized here:

Gasoline spills can best be identified by their odor and rapid burning of the turf. Leaf kill occurred within one hour following a gasoline spill.

Motor Oil caused a shiny, slick appearance on the grass which persisted for over 48 hours. Damage due to motor oil was slow to occur compared to gasoline, hydraulic fluid, or brake fluid.

Hydraulic fluid was similar to gasoline in its initial symptoms on the turf. Leaf kill was not quite as rapid of that following gasoline spills, and the odor of hydraulic fluid was different from that of gasoline.

Brake fluid also had a characteristic odor and caused the turf to turn a pale, greyish-green color that progressed to a light yellow color just before death of the turf. Leaf kill occurred within 24 hours.

Grease spills are usually small spots and are characteristically identified by a distinct layer of grease on the surface of the leaves. The grease spill was much slower in the rate of leaf kill compared to the other products, including motor oil.

*Johns, D. and J. B. Beard. 1977. Petroleum spills on fine turf. In Turfgrass Research Report: Texas A&M Turfgrass Field Day. June 1977. Department of Soil & Crop Sciences Information Report No. 77-54.

## Results of Corrective Treatments

The recovery rate of the bermudagrass and the effectiveness of the corrective treatments in enhancing recovery can be summarized as follows:

GASOLINE. The turf achieved 85-100% recovery within 4 weeks of the spill. None of the corrective treatments were effective in enhancing recovery.

MOTOR OIL. Detergent proved to be an effective corrective treatment for motor oil spills as the bermudagrass achieved 85% recovery within 4 weeks and 95-100% recovery within 8 weeks following the spill. The activated charcoal and calcined clay fines were not as effective since the turf achieved less than 50% recovery in 8 weeks.

HYDRAULIC FLUID. The results for hydraulic fluid spills and corrective treatments were the same as those for motor oil. Detergent was the most effective corrective treatment to enhance turfgrass recovery as the bermudagrass achieved 85% recovery in 4 weeks as compared to 30% recovery in 4 weeks with both activated charcoal and calcined clay fines.

BRAKE FLUID. Brake fluid was quite water soluble. From 90 to 100% recovery was achieved in 4 weeks on the waterdrenched check plot. Detergent, however, speeded full recovery to within 2 to 3 weeks following the spill.

GREASE. Unfortunately none of the corrective treatments studies were effective in enhancing turfgrass recovery following a grease spill. The Tifgreen bermudagrass required 8 to 10 weeks to recover from a grease spill.

In conclusion, detergent proved to be an effective corrective treatment for motor oil, hydraulic fluid, and brake fluid spills. A summary table showing recommended corrective treatments and recovery times for bermudagrass following five petroleum spills is shown in Table 3. When used, the detergent should be sprinkled over the spill area, thoroughly drenched, and then completely removed from the surface area, preferably with a vacuum. It should be noted that it is important to treat a petroleum spill even if the turf is severely damaged. Removal of the petroleum residue will enhance recovery of the turfgrass.

Table 3. Summary of recommended corrective treatments and recovery times for bermudagrass following five petroleum spills.

| Petroleum Product | Recommended Treatment | Recovery Time (Weeks) | |
|---|---|---|---|
| | | Treated | Untreated |
| Gasoline | None | (4) | 4 |
| Motor Oil | Detergent | 4 | 8-10 |
| Hydraulic Fluid | Detergent | 4 | 8-10 |
| Brake Fluid | Detergent | 2-3 | 8 |
| Grease | None | 8-10 | 8-10 |

# INOCULATION AND IDENTIFICATION OF THE FUNGUS CAUSING DOWNY MILDEW OF ST. AUGUSTINEGRASS

by

Benny D. Bruton, Robert W. Toler and Richard A. Frederiksen*

## INTRODUCTION

Downy mildew of St. Augustinegrass, Stenotaphrum secundatum, has been an ever increasing problem in recent years. The disease has been found to be destructive on sod grown in low lying flood proned areas.

Jones and Amador (2), in 1969, first reported a downy mildew disease of St. Augustinegrass occurring in Florida and Texas; however, positive identification of the pathogen was not determined. Occurrence of the disease was again reported in 1972 by Dale and Toler (1) in Arkansas. Downy mildew has subsequently been observed in most of the St. Augustinegrass growing areas of Texas.

Very little or no damage was ascribed to the disease when it was first observed (2). However, Toler and Walla (4) in 1973, reported some damage occurring in the Bay City, Texas area. In the spring of 1977, severe damage was observed on both Texas Common and Floratam St. Augustinegrass at Bay City.

Objectives:

1. Identify the species of fungus causing downy mildew of St. Augustinegrass.
2. Develop a technique for the artificial inoculation of Sclerophthora macrospora.

Methods and Materials:

Two St. Augustinegrass cultivars, Texas Common and Floratam, one inbred grain sorghum (Tx09) and one maize inbred (OH 545) were artificially inoculated using a modification of Semeniuk and Mankin's technique (3). Mature St. Augustinegrass clipped at 3.8 cm height and seedlings of grain sorghum and maize at the two leaf stage of growth were used for the inoculation procedure. Each treatment was replicated four times. The plants, in one liter plastic pots, were flooded by emersing in a No. 10 wash tub filled with tap water. The plants in the individual pots were

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restricted in the flooding container by a plastic cylinder fitted inside the one liter pots. The water was adjusted to level just covering the leaves with the tubes extending above the water surface. With this technique, the inoculum can be restricted to the immediate area for each species to be inoculated. Mature St. Augustinegrass leaves showing typical downy mildew symptoms were used as inoculum. Leaves were floated on the surface of the water for 24 hours. The inoculation procedure was performed in an environment chamber with a temperature of 18°C and humidity at 100%. Plants were removed from the environment chamber after 24 hours and placed on a bench in the greenhouse.

Results and Discussion:

Numerous lemon-shaped asexual sporangia (40-61 x 64-90μ) were produced on the upper surface of the leaves floated on water. Jones and Amador (2) reported sporangial production at 21°-29C; but did not observe zoospore production. Our research has shown that both sporangia and zoospores are produced abundantly at 18°C. Oospores were not observed on St. Augustinegrass by Jones and Amador (2) and the present research further confirms their absence. Absence of oospore production in some hosts; however, is not uncommon.

Identification of the downy mildew on St. Augustinegrass without oospores is difficult; however, there are few downy mildews that infect both grain sorghum and maize under natural conditions. These are: Sclerospora sorghi, Sclerospora philippinensis, Sclerospora gramincola, Sclerospora spontanea and Sclerophthora macrospora. All these downy mildews reproduce asexually by means of conidia except for Sclerophthora macrospora which reproduces by zoospores.

Systemic development of the fungus in both maize and grain sorghum produced shortening of internodes and thus the characteristic crazy top symptoms when inoculated with S. macrospora. Raised, light colored, linear streaks run along the leaf veins of all plants inoculated including Texas Common and Floratam St. Augustinegrass, maize, and grain sorghum. On the basis of sporangia development, morphology, zoospore production and host range on St. Augustinegrass, maize and grain sorghum, the fungus causing downy mildew on St. Augustinegrass can be correctly identified as S. macrospora (Sacc.) Thirum., Shan, and Naras. This does not preclude the possibility of a different race attacking the St. Augustinegrass; however, no physiologic races of S. macrospora are known.

Incubation in days for the test plants were: Texas Common St. Augustinegrass - 17, Floratam St. Augustinegrass - 13.5, grain sorghum - 12.5, and Maize - 9. Initial screening of ten St. Augustinegrass cultivars for resistance to downy mildew suggests that all cultivars may be susceptible; however, there is evidence of varying degrees of disease severity.

Control:

Disease Free Stock - Selection of disease free stock in an important aspect of disease control from the standpoint of exclusion.

Avoid Flooding - Flooding is essential for infection of zoospores and spread of the disease. Construct turf area such that drainage is fast and complete.

Chemical Control - Fungicides screening for downy mildew control has been very limited; however, Toler and Walla (4) did report reduced disease incidence by Dyrene.

Resistance - Screening St. Augustinegrass cultivars is in the initial stages so that definitive data cannot be presented. All cultivars thus far tested have been susceptible to infection; however, the data does suggest varying levels of resistance.

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# REGROWTH ENERGY OF KENTUCKY BLUEGRASS

by

Garald L. Horst and Jerry M. Carter*

Interest in arid southwest turfgrass culture is increasing rapidly. Migration of people to the moderate climate of the Southwest has created population pressures and a demand for heat-tolerant grasses.

Increasing population has enhanced the need for parks and recreational areas. In addition, the mild winters facilitate year-round use of these areas. Therefore, cool-season turfgrasses have become necessary. However, environmental stresses of high summer temperatures complicate management practices and indicate a need for stress adapted cool-season turfgrass species.

Warm-season species are utilized in most Southwestern turfgrass application. Selected areas are overseeded every fall for winter greenness. Knowledge of adapted species and management practices utilizing cool-season turfgrass species on a year-round basis in the Southwest is in need of upgrading. Research was initially needed on cool-season turfgrass evaluation in order to determine selection criteria most useful in turfgrass improvement programs. In addition, management practices need to be evaluated to increase the usefulness of selected cool-season turfgrass.

Objectives of this turfgrass research were to develop and evaluate methods of measuring turfgrass response to environmental stress conditions, evaluate the basis or cause for differences in plant response to stress conditions, and develop evaluation methods and basis for plant response differences into selection criteria for turfgrass improvement.

## Materials and Methods

The research procedure was as follows: We selected bluegrass varieties from a wide range of environments and grew these diverse bluegrass varieties under the best presently accepted cultural practices used in the Southwest. Then we measured various morphological and physiological plant responses under these conditions.

We used thirty-four varieties, replicated four times each. Monthly sampling was started in March, 1976. A bulb planter was used to remove

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a plug of sod from each Kentucky bluegrass plot. The existing turf was cut to two centimeters and the sod plug placed in an open glass jar. Water was added as needed to the sod plug to maintain it at field capacity. The sod samples were placed in a dark chamber and allowed to regrow at a temperature maintained at 21 C. Regrowth from each sod sample was harvested, dried, and weighed weekly. Each sod sample was harvested weekly until regrowth stopped.

Results and Discussion

Regrowth reserves are essentially the stored energy bluegrass plants have available to utilize for regrowth change throughout the year. The regrowth reserves were greatest when the soil and air temperatures were lowest as indicated by the values for the spring, fall, and winter months (Figure 1). In contrast, the regrowth reserves were lowest during the summer months when the soil and air temperatures are highest in September as indicated by the low values.

The low values for regrowth reserves during the summer months may be due to several factors. Growing conditions in the summer may cause the bluegrass plants to divert stored energy to topgrowth or the energy reserves may be utilized in maintaining the plants under high temperature stress conditions.

The rate of regrowth reserve utilization was also influenced by annual growing conditions (Figure 1). Length of time that bluegrass regrowth from stored energy was maintained in the dark appears to be related to the level of stored energy. However, during the cooler months of the year, regrowth duration did not necessarily increase with increased levels of stored energy.

From the group of thirty-four bluegrass varieties, four were selected as being representative of a wide range in environmental adaptation. The average regrowth reserves of these four varieties at five dates indicates a difference in the rates of regrowth reserve depletion among the four varieties (Table 1). Regrowth reserve levels for Delta decline rapidly after March and remain low until November. The values for Adelphi are maintained at high levels until September.

Differences among the four selected bluegrass varieties are also evident in regrowth duration (Table 2). On an annual basis, both Delta and Victa have lower times of regrowth maintenance in relation to Adelphi and Bonnieblue. This is demonstrated by the much lower values for Delta and Victa as opposed to the values for Adelphi and Bonnieblue during the September sampling period.

By dividing the values of Table 1 by the values of Table 2 the daily regrowth energy production can be calculated (Table 3). Daily regrowth energy production may be used as an estimate of regrowth energy utilization efficiency. Comparison of values reported for September 1976,

indicates Adelphi and Bonnieblue have values almost one-half those of Delta and Victa. This could be interpreted to mean that Adelphi and Bonnieblue underwent a genetically controlled, short term adaptation to higher environmental temperatures in September. This adaptation mechanism may be the reason for stress resistance differences observed in bluegrass varieties when they are under environmental stress conditions such as high temperature.

## Conclusions

In conclusion, this research data indicate a bluegrass varietal difference in responses to environmental stresses. There is additional information on bluegrass metabolism response to stress conditions.

The research methods reported herein may be used as a basis for further selection and evaluation of bluegrass varieties to environmental stress conditions. This line of research may result in cool-season grasses which are easier to maintain on a year-round basis in the Southwest.

FIGURE 1.

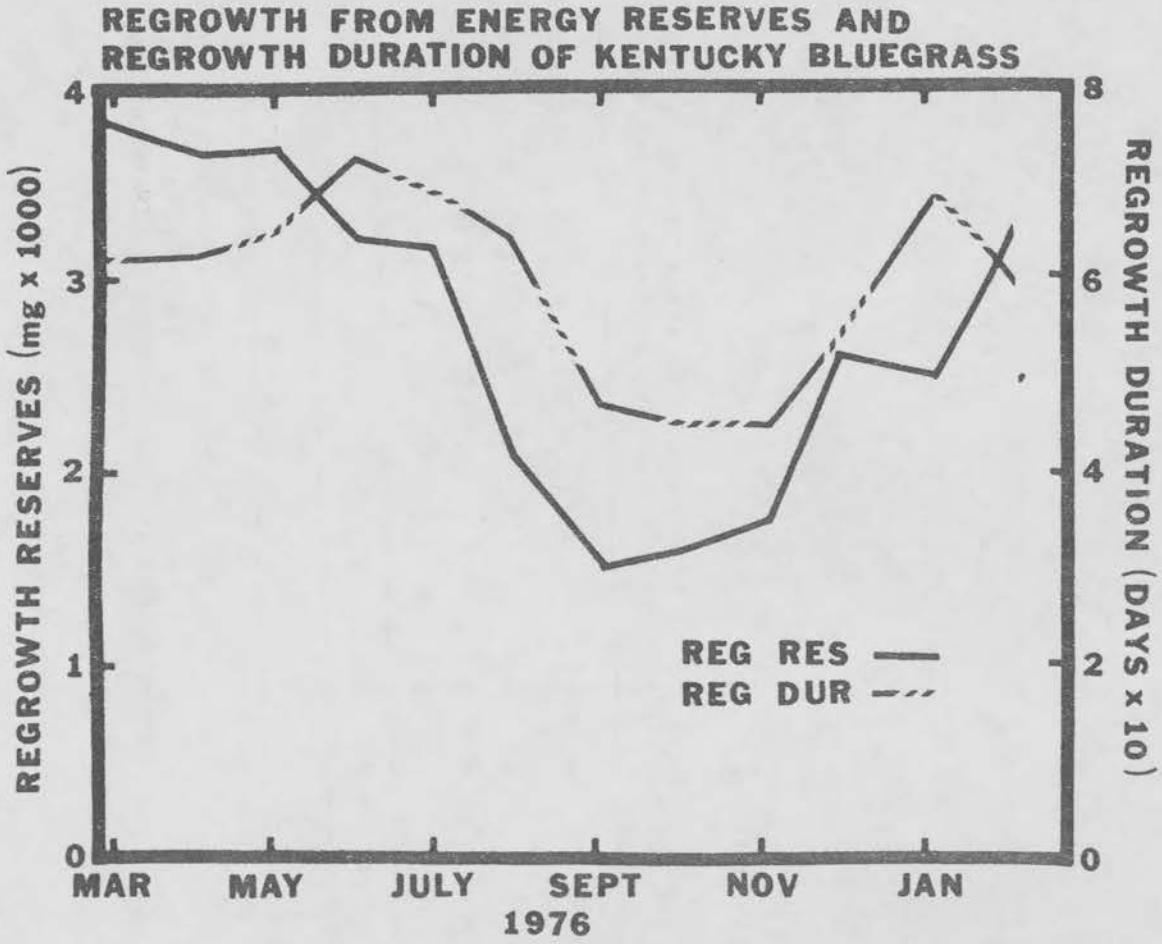
REGROWTH FROM ENERGY RESERVES AND
REGROWTH DURATION OF KENTUCKY BLUEGRASS
REGROWTH RESERVES (mg x 1000)
REGROWTH DURATION (DAYS x 10)
0
1
2
3
4
0
2
4
6
8
REG RES
REG DUR
MAR
MAY
JULY
SEPT
NOV
JAN
1976

Table 1.

Average Regrowth Reserves (gm) of Four Kentucky Bluegrass Varieties.

| | 1976 | | | | | |
|---|---|---|---|---|---|---|
| Variety | Mar. | May | July | Sept. | Nov. | (Sign.) |
| Delta | 3.3 a[1] | 2.6 b | 2.1 b | 1.2 a | 1.3 a | * |
| Victa | 3.8 a | 3.8 ab | 3.3 ab | 1.8 a | 2.4 a | * |
| Adelphi | 3.7 a | 4.4 a | 4.1 a | 1.7 a | 1.8 a | * |
| Bonnieblue | 2.7 a | 3.5 ab | 2.8 ab | 1.6 a | 2.5 a | * |

[1]Means within a column followed by the same letter are n.s. at 0.05 level. *Significance between dates, 0.05.

G. L. Horst

Table 2.

Average Regrowth Duration (days) of Four Kentucky Bluegrass Varieties.

| | 1976 | | | | | |
|---|---|---|---|---|---|---|
| Variety | Mar. | May | July | Sept. | Nov. | (Sign.) |
| Delta | 64 a[1] | 49 b | 47 c | 26 b | 30 b | * |
| Victa | 63 a | 51 b | 65 bc | 43 ab | 41 ab | n.s. |
| Adelphi | 64 a | 94 a | 96 a | 64 a | 46 ab | * |
| Bonnieblue | 66 a | 73 ab | 77 ab | 62 a | 64 a | n.s. |

[1]Means within a column followed by the same letter are n.s. at 0.05 level. *Significance between dates, 0.05.

G. L. Horst

Table 3.

Average Daily Regrowth Energy (mg/day) of Four Kentucky Bluegrass Varieties.

| | 1976 | | | | | |
|---|---|---|---|---|---|---|
| Variety | Mar. | May | July | Sept. | Nov. | (Ave.*) |
| Delta | 52 | 52 | 44 | 46 | 43 | 46 |
| Victa | 59 | 75 | 51 | 42 | 58 | 53 |
| Adelphi | 57 | 47 | 43 | 26 | 40 | 44 |
| Bonnieblue | 41 | 48 | 37 | 27 | 40 | 39 |

* 12 Month Average

G. L. Horst

# ROOT AND SHOOT RESPONSES OF ST. AUGUSTINEGRASS TO WATER STRESS AS INFLUENCED BY POTASSIUM*

by

J. M. DiPaola and J. B. Beard**

The distribution and amount of rainfall is often not adequate for the maintenance of high quality turfgrass areas. More often than not, the peak water use period of a turf coincides with the dry summer months. Supplemental irrigation must then be utilized during these periods in order to maintain a quality turf possessing an adequate recuperative potential. Rising costs for water of decreasing quality necessitates the evaluation of cultural practices which will reduce the quantity of water required to maintain an acceptable turf.

The objectives of this investigation were two fold. First, to determine the root and shoot responses of St. Augustinegrass to soil moisture deficits. Second, to determine the influence of increased potassium fertilization rates on turfgrass quality and root growth characteristics of St. Augustinegrass.

## RESEARCH PROCEDURE

Two studies were conducted using Floratam St. Augustinegrass. The first was initiated in late summer of 1976 and utilized a rhizotron having forty-eight root observation boxes. Each compartment or root observation box was 30 inches high, 12 inches in depth, and 10 inches wide. This facility permitted continuous and convenient, non-destructive observations of root growth on the inward slanting glass facing of each root observation box. Complete details of the rhizotron and its construction were presented in an earlier paper by these authors (3).

The second study was conducted in the greenhouse during the spring of 1977 using larger root observation boxes of similar design. These boxes were 4 feet high, 12 inches in depth, and 7 inches wide.

Floratam St. Augustinegrass sods were transplanted onto the sand within the root observation boxes that had previously received three pounds of actual phosphorus per 1000 sq. ft. mixed into the top four inches of the soil. Sand was utilized as a rooting medium to facilitate root washing and dry weight determinations of the St. Augustinegrass turf and

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* This investigation was partially supported by a grant from the Texas Sod Producers Association.

to prevent breaking of the glass face during the expanding (wetting) and shrinking (drying) of the clays. The turfs were then maintained at a two-inch cutting height (clipped weekly) and received one pound of nitrogen per 1000 sq. ft. per month. Four potassium fertilization rates (0.25, 1.0, 3.0, and 5.0 lbs K/1000 sq. ft./month) were included in the rhizotron study, and two potassium fertilization rates (1.0 and 5.0 lbs K/1000 sq. ft./month) in the greenhouse study. Half the turfed compartments received no further applications of water after a five-week sod establishment period. Each treatment was replicated three times. Most of the data presented in the paper will be from the greenhouse investigation. Data collected included daily root growth rates, number of actively growing roots per day, root dry weights, visual turfgrass quality ratings, and clipping dry weights.

## RESULTS

Cessation of water applications significantly reduced the turfgrass quality ratings of the Floratam turfs. The turfgrass quality (1 to 10 basis; 10=best) of the stressed turfs was significantly decreased in comparison to that of the controls after eight days without water. Stressed turfs had a turfgrass quality rating of only 5.3 after twenty-nine days without water compared to a rating of 9.6 for the watered turfs on the same data.

Increased potassium fertilization rates from 1 to 5 lbs K/1000 sq. ft. /month significantly improved the turfgrass quality ratings through the first 14 days without water application in the rhizotron study. A similar trend, though not statistically significant, was observed in the greenhouse experiment.

Plant water stress symptoms included a blue-gray to dull green leaf coloration, followed by a folding of the wilted leaves. Healthy, turgid leaves would appear open and expanded. The leaf appearance would progress from a folded, toward a more rolled leaf shape as water became more and more limiting. Severe water stress resulted in a very tight, irreversible rolling of the leaf blade about the midrib.

Shoot growth, measured as clipping dry weight, decreased significantly with the progressing soil moisture deficits. After twenty-nine days without water, the stressed turf clipping dry weights were approximately one third that obtained from the watered turfs. Increasing potassium fertilization rates from one to five pounds/1000 sq. ft./month did not significantly affect the clipping dry weights obtained from the turfs during the water stress period.

Root responses to increased potassium fertilization were much greater than those observed for the shoots. Exposure to soil moisture deficits significantly reduced both the number of actively growing roots per day and the daily root growth rate (cm/day) of the Floratam turfs. The stressed turf daily root growth rate was 18% slower, on the average, than that of

the watered turfs. Increased potassium fertilization significantly increased the daily root growth rate observed for both the watered and water stressed turfs.

Root growth of Floratam St. Augustinegrass does not occur at a uniform rate throughout an entire day. The nocturnal or night-time root growth rate was some 20% greater, on the average, than that of the daylight period. This response is explained by the more favorable water balance within the plant during the nocturnal period when only minimal transpiration is occurring.

Following the water stress treatment the turfs were allowed to recover for 14 days and were then prepared for root dry weight determinations. The entire root system was washed free of sand, sectioned into four inch length increments, and finally ashed to constant weight in a muffle furnance.

Examination of the root systems from the root observation boxes revealed extensive root development under both the watered and water stressed treatments. All turfs had some roots reaching a depth of 4 feet in the sand medium. Total root dry weights were found to significantly increase with increased potassium fertilization. Turfs receiving 5lbs K/1000 sq. ft./month had total root dry weights about 30% greater than that of the turfs receiving 1 lb K/1000 sq. ft./month. Previous exposure to moderate soil moisture deficits significantly increased the total root dry weights. Root dry weights of the water stressed turfs were 29 and 36% greater than the watered turfs for the 1 and 5 lb K/1000 sq. ft./month treatments, respectively.

While root growth did reach a depth of four feet in the sand, a majority of the roots occurred in the upper 16 inches of the soil. Previous exposure to soil moisture deficits significantly increased the proportion of the total roots found at the deeper soil levels (greater than 2 feet). Such a growth pattern would enhance the removal of water that is available at the lower soil depths.

While increased potassium fertilization significantly increased the root dry weight for any given soil depth, increased potassium fertilization did not significantly influence the distribution of roots within the soil profile. There was a trend however, towards an increase in the proportion of the total dry weight found in the intermediate soil depths (1 to 3 feet). This was not statistically significant however.

The following conclusions can be reached as a result of these investigations:

1. Floratam turfs maintained at a 2-inch cutting height were capable of rooting to a depth of 4 feet in sand. The majority of the roots were located in the upper 16 inches of the soil, however.
2. The nocturnal root growth rate of Floratam St. Augustinegrass was 20% greater on the average than the daylight root growth rate.

3. Previous exposure to soil moisture deficits significantly increased the total root dry weight of the Floratam turfs.

4. A greater proportion of the roots occurred in the lower soil depths when the turfs were previously exposed to soil water deficits.

5. Increasing potassium fertilization rates significantly increased the total root dry weight, while having no significant effect on the distribution of roots within the soil profile.

6. These investigations emphasize the importance of adequate potassium fertilization in promoting increased root development of St. Augustinegrass.

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