Proceedings

of the

Twenty-Ninth Annual
Texas Turfgrass Conference

TEXAS A&M UNIVERSITY

and

THE TEXAS TURFGRASS ASSOCIATION

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PREFACE

Turf constitutes a major Industry in Texas, consisting of lawns, parks, golf courses, athletic fields and other facilities in addition to the people, equipment and supplies required to maintain these facilities. Also, the Turf Industry plays a significant supporting role in areas of tourism, recreation and land development. Maintenance of these turf facilities has become alarmingly expensive due to dramatic increases in costs of fertilizer materials, pesticides, equipment, and labor. As an example, maintenance costs per golf hole averaged $4,577 in 1970 and approximately $6,500 in 1974. Because of the value of the Turf Industry to the State of Texas and the costs of maintenance of turf facilities, highly trained supervisors, managers and maintenance personnel are needed in the Turf Industry. These *Proceedings of the Twenty-Ninth Texas Turfgrass Conference* are published with the intention to provide basic knowledge and specific recommendations for turf managers and to introduce new approaches, concepts and ideas to people involved in the Turf Industry.

As program chairman for *The Twenty-Ninth Texas Turfgrass Conference*, I want to express sincere appreciation to each speaker on the program for presenting useful and current information. These *Proceedings*, taken from those presentations, make a valuable reference for the people of Texas working in the Turf Industry.

Also, special appreciation is extended to Brenda Landry, my secretary, for her valuable assistance with both the Conference and these *Proceedings*.

Richard L. Duble
Program Chairman

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WELCOME COMMENTS

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In January, 1947, The Texas Turfgrass Association was organized at the first annual Turfgrass Conference held at Texas A&M University. The printed program for that first conference described the purpose of the meeting as follows: "To give interested persons an opportunity to discuss their problems with each other, to present information that is basic to all turf work, and to give workers in the field a broader appreciation of the many factors involved in the management of turf facilities." Again quoting from that original program, "Good turf for public and private use is assuming great importance in the Southwest. More extended use of turf for beauty and recreation is a desirable part of the plan for a more enjoyable post-war period."

These purposes and observations are as valid today as they were in 1947, and reflect the foresightedness of the charter members of the Texas Turfgrass Association. Even today, with the interest in beautification and conservation and the pressures placed on the turf industry by inflation, environmentalists, and the public, the purpose of this conference is adequately defined by that original program.

Also, a resolution was passed at the first annual banquet of the Association "urging Texas A&M to include within the limits of its resources, suitable provisions for developing research on all phases of turf management and grass breeding, an Extension program to carry the results of the research to all the people of Texas, and a teaching

program to develop well-trained leaders in the field of turf-culture." All of these programs have been implemented at Texas A&M University since that resolution was adopted in 1947. And, as the needs have been identified and commitments made by Texas A&M and the turfgrass industry, these programs have been strengthened, as in September, when Richard Duble was employed as Extension Turf Specialist. These three facets of the Turfgrass Industry - research, teaching, and Extension - as envisioned by the charter members of this Association emcompass all aspects of professional involvement in the turfgrass industry.

Texas A&M University has long recognized the value of the turf industry in Texas and the need for a strong program in turf. Recently, turf programs in teaching, research, and Extension have been expanded at College Station and Dallas. Since 1947, the origin of the Texas Turfgrass Association, our staff, involved in turf, has increased from one part-time member to seven full-time members and 25 full-time graduate and undergraduate students. Approximately 100 students have graduated in our turf program and are presently involved in the turf industry. Indications are that both staff and student numbers, involved in turf, will continue to increase.

In the area of professional development of people working in turf, the Texas Agricultural Extension Service plans to increase the number short courses, workshops, clinics, and demonstrations throughout the State. We are responsive to the needs of the turf industry, so if you see needs that are not being met we would appreciate hearing about them.

The Texas Turfgrass Association and Texas A&M University have had a mutually profitable association, and together, have grown to meet the needs of a rapidly growing industry. To continue to provide leader-

ship to the industry, the Texas Turfgrass Association must continue to meet the needs of the people it serves. Perhaps the newly formed past-presidents advisory committee will provide new purposes, programs and opportunities for the membership of the Texas Turfgrass Association. Certainly, they could not be more appropriate than were the original goals established in 1947; but new approaches or objectives may be needed to meet the growth that is predicted in the area of open developments and recreational centers.

We certainly hope that the educational programs, exhibits, and business sessions planned during the next 2½ days, will encourage new ideas and continued cooperation between the Texas Turfgrass Association and Texas A&M University.

SHORTCOURSE ON PRINCIPLES OF TURF MANAGEMENT

MOWING

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The essentiality of mowing grass to produce fine turf has been recognized for many years but it is difficult to determine when the practice first began as we know it today. It is interesting to note that the first golf greens in Scotland were areas where the sheep and rabbits had cropped the grass very close to the ground. This may also be how the effects of clipping grass closely to produce a desirable condition of growth was first noticed. With this end in mind, the first crude mowers were invented.

As early as 1830 a man named Edwin Budding conceived the idea which produced the first rotary mower and then in 1900 the first gasoline-driven lawn mower was produced. Only in comparatively recent years was the vertical mower introduced. Today we have a wide selection of mowers available for almost every purpose. We even have trimming machines working on the impact principal using some kind of flexible cord in place of a rigid blade.

Proper mower selection is very important and each job should be evaluated from the standpoint of the size and type of mowing machine that will do the job most effectively and efficiently. Basically, there are four general categories of mowers available -- reel, rotary, sickle bar and vertical. Each has its own special capabilities and limitations as do the hundreds of variations within each general category.

Whichever mower, or mowers, you select should be chosen for maneuverability, ease of adjustment, durability, and adequacy of horsepower for the usage expected. In addition, the availability of parts and service is important.

The reel-type mowers are ordinarily used on fine turf such as greens, tees and fairways because with this type of mower the grass is clipped with as little

damage as possible to the plant. As a rule, the finer the turf, the more blades the reel should have and the closer they should be spaced so they contact and clip the grass leaf blades in smaller bunches to give a smoother cut.

With the advent of the gasoline powered greens mower, there followed concerns about extra weight and vibration causing soil compaction and other problems not previously experienced. Acceptance, however, was quick in coming when the advantages were fully realized through use. In more recent years, we have gone through the whole acceptance routine again with the triplex riding greens mower. No doubt, it has some problems not encountered with the walk behind units, but its advantages were soon recognized and few golf courses today can be found without one or more of these machines on the inventory.

The triplex putting green mowers are without a doubt the most sophisticated mowing machines ever produced and are consequently the most expensive greens mowers ever produced. As with any mowing unit however, the initial cost is incidental when compared with the cost of the units replaced, the manhours saved and its total capabilities for getting the job done more efficiently without loss of quality.

Even though these triplex greens mowers have been used at one or two clubs to mow fairways on occasion, it is rather obvious that these machines are not meant to be used for such purposes or for larger rougher areas where large volumes of material are removed.

For roughs the rotary mowers or hammer knife types are best suited because control of vegetation rather than superb appearance is most important here. These mowers may also be used for mulching leaves, cutting tall stemmy weed and small brush, and the smaller models are most often used for trim work.

Rotary mowers cut by impact and for this reason, a sharp, well-balanced blade is necessary to avoid mutilation of the grass leaf blades as well as to avoid excess vibration of the machine and prolong engine life.

Sickle-bar mowers are different from other types of mowers and have limited use under normal turfgrass conditions. They are primarily used in rank, weed growth that may require mowing at an angle or for farm purposes where the grass tops (hay) is harvested. Any other type of mower would mulch or otherwise destroy the material removed. These mowers are extensively used by Highway Departments and have the distinct advantages of safety and widely variable height of cut settings. The main disadvantages are high cost of maintenance and slow ground speed.

Vertical mowers are much the same as rotary types in mowing principal, but the blades are set in a vertical plane rather than horizontally. These mowers are made with fixed or free-swinging blades of various types and are capable of lightly combing the grass to remove grain or slicing the soil to remove thatch and open channels for better air and water penetration. The hammer-knife units with free-swinging vertical blades are usually employed in rough areas.

This is a very brief sketch of the types of mowers and their uses which I believe may be covered in much greater detail on another part of the program. It is important at this point, however, to recognize that although mowing turf is accomplished either by clipping or by impact, there are many different types of mowing machines with many different uses. Considering all the variations of grass cutting, this is a major operation at any golf course which accounts for approximately one half of the labor budget.

Good mowing practices contribute to the well groomed appearance and

playability of a course as well as to the health, vigor and density of the turf itself. A better understanding of the growth habits and characteristics of grass as they relate to mowing may give some insight as to how this practice is or should be done.

The ability of grasses to withstand frequent and relatively close cutting is related to certain peculiarities of the grass family. Grasses exhibit basal growth as opposed to terminal growth found in most other plants. This simply means that the growing point is not removed by normal mowing and that excess material may be removed without serious injury to the plant.

Mowing height and frequency are determined in large measure by the growth rate and the growth habit of the plant. Other considerations such as the intended use of the turf enter into the picture but very often conflict with, rather than augment, sound agronomic principles. A prime example is the constant insistence that bluegrass fairways be cut shorter like bermuda. A northern problem? Well, I thought it was too, until this year I heard some people in bermuda country complaining that their fairways were too short and should be cut more like bluegrass. Very generally stated, commercial bluegrass species survive regular mowing at less than one inch with great difficulty, if at all, while bermudagrass regularly mowed as high as one inch would not tighten up properly and the thatch development on a fairway would be almost impossible to control.

Again, I say these are very general statements because time will not permit a discussion of the growth habits of each turf species. It is most important however, that you become thoroughly familiar with the growth habits of the turf species you are working with, otherwise, your management capabilities will be severely limited.

There are bunch-type grasses such as tall fescue, rygrass, chewings

fescue, and Colonial bentgrass.

There are stoloniferous and rhizomatous type grasses, such as creeping bentgrass, creeping red fescue and almost all of the warm season grasses including bermuda, St. Augustine, centipede, bahia and zoysia.

Some of these grasses may be cut short, say 3/16 inch or less, because they have good shoot density originating from a point on the crown of the plant very close to the ground. Others may do well at this height because they have very short internodes as well as good shoot density and the capability for initiating new growth at each node on the stolons and rhizomes.

The strictly bunch type grasses seldom survive very long (more than a season or two) at putting green height, but may be used as an annual such as a ryegrass overseeding when sown thickly. They are most often upright in growth habit and need to be cut higher in terms of inches, rather than fractions of an inch, to leave enough leaf surface on each plant to sustain its proper growth, or in some cases, its survival.

There are any number of good reference books on the market where the growth habits of individual turf species are described, and I believe that a limited amount of reading on the subject will not only interest and amaze you, but also may help you better answer some of the questions your members or your green chairman may ask. Most of us know that we cut certain grasses at a certain height because it doesn't grow well at higher or lower cuts or because it's recommended, but the fellow who is really interested in turf won't be satisfied until he knows some of the reasoning behind the recommendations. "If you cut it that low now, it's gonna die," is a very reasonable and practical answer for your green chairman, but you may be left standing with egg on your chin and orders to do it anyway if he whips back at you with the simple question any three year old child might ask,

"Why?". On the other hand, a modest amount of homework could get you off the hook and instill in your boss a great deal of admiration for your knowledge about turf matters.

How do management practices and environmental conditions affect mowing? We know, of course, that water, fertilizer, and disease control when properly applied increase the need for mowing just as does favorable temperature, good soil and adequate sunlight.

As the grass begins more rapid growth during favorable periods of the year, we should adjust our mowing schedule accordingly. This not only makes the turf more playable to the golfer, but also helps maintain the grass plant itself in better condition.

Grass blades are long and flattened, adapted for intercepting a maximum of the sun's rays which are necessary for food production within the plant. A severe reduction of the leaf area (in most cases removing more than 1/3 or 1/4 of the total leaf surface at one time) will result in a severe shock to the whole plant. The same principle applies whether the turf is cut at 3/16 inch or 3 inches. It is just that removing 1/4 of the growth at a 3 inch height puts a lot more clippings in the catcher than you get at 3/16 of an inch but the ratio is the same.

Along the same lines, shorter heights of cut necessitate more frequent mowing. We can see why if we follow the rule about removing no more than 1/3 of the turf top growth at any one mowing. A turf at 3/16 of an inch may easily produce 1/16 of an inch of new growth in a 24 hour period while turf at a 3 inch height might require 3 to 5 days to produce 1 inch of new growth.

Not all grasses are suited to close clipping for prolonged periods as are the varieties normally used on putting greens, but almost any species will initiate new shoot growth when first clipped shorter. This new growth

produces a greater shoot density per unit area and narrower leaves. This is certainly a desirable effect, but the new growth is usually produced at the expense of the roots and underground parts of the plant which are used to store carbohydrates. These are the simple sugars and starches metabolized within the plant to generate new growth and sustain the old. To compensate for this loss, we must intensify the management given any turf area as cutting height is decreased and by knowing the growth habits of individual species, as was suggested before, we will be better able to choose species which need less compensation and/or will better adapt to the desired mowing height.

New growth, as generated by clipping, is always more succulent and therefore more susceptible to disease. This at least partly answers why we have more disease on putting greens than on the other areas of the course where turf is higher and cut less often.

A bruised or torn grass blade caused by a dull or poorly adjusted mower is an excellent port of entry for disease as well as a source of increased loss of vital plant fluids.

Thanks to the systemic fungicides now on the market, we have less worries about losing the protective materials we have just applied, through mowing. This is still a concern however, when contact fungicides are used alone or in combination with systemic materials to control specific diseases. New shoot growth, as induced by frequent and close mowing, is not protected by contact materials, therefore, we must apply these fungicides more frequently under these conditions. It would also be inadvisable to apply contact fungicides just prior to mowing on the same day for any number of reasons.

Applications of dry fertilizers and other granular materials such as fungicides, insecticides and herbicides should not be scheduled just prior

to mowing since a portion of the product will be removed with the clippings. To avoid excessive loss of these beneficial materials, they should be applied when the turf is dry and then incorporated into the turf below the level of the mower as much as possible by washing them in and/or brushing, combing, or polling the green surface. You may also wish to skip the next day's mowing or mow one or two times after the application without the catchers.

Some of the special mowing problems often encountered are grain, wet conditions, uneven terrain and improper mower operations.

Quite frequently, a very strong grain is encouraged by mowing in the same direction each time. Before long the grass blades will tend to orient themselves in the direction of mowing and the mower will slide over much of the grass without cutting it. For this reason the direction of mowing should be changed each time the area is clipped.

Sometimes grass will just naturally develop grain even though mower direction is being changed. To minimize the effect of grain on the golf ball there are special attachments for most mowers such as combs or brushes. One of the best tools we have for this purpose, however, is the vertical mower, especially the triplex units, which in one operation can do more to eliminate grain than four or five brushings or combings.

The walk behind vertical mowers are sometimes risky to use, especially on bent greens during the summer months, but the triplex units when properly adjusted so that the mower blades just nick the tips of the grass blades, can be used as often as necessary under normal conditions. Some superintendents use these units about once a week during the growing season with good results.

Mowing wet grass should be avoided when possible because dry grass is easier to clip, takes a little less time, does not ball up and clog the

mower and the finished product is much neater. Disease is also encouraged by clumps of wet clippings, and large accumulations of this type of material often result in yellow spots or outright kill of spots of turf in fairways to say nothing of the unsightly appearance and detrimental effect on the golfer.

When mowing saturated turf is unavoidable, it is sometimes a good idea to slightly increase the height of cut to compensate for the swelling of thatch and the sinking of the mower into the soft surface. The swelling of thatch is even more pronounced after long dry periods followed by moderate to heavy natural rainfall. A slight increase in the height of cut may also help the turf survive periods of extreme stress of many kinds.

Uneven terrain is the cause of much scalping of the grass and damage to mowing equipment. The only answer to this problem is leveling by filling depressions or regrading rough areas. It is impossible to obtain a smooth, neat-looking job of mowing and uniform turf growth when the ground surface is uneven. Insects, too, can cause some serious mowing problems if not properly controlled. Ants, earthworms, gophers, and other soil-burrowing animals throw up mounds of earth which not only give the turf area an unsightly appearance but tend to clog and dull the mowing units.

Of extreme importance to the mowing operation is the human element. The mower operator must be alert and know how to operate the machine properly. Two of the most common faults are excessive speed and turning too sharply. The excessive speed causes a washboard effect in the turf which gives a very uneven appearance while sharp turns tend to bruise or scalp the grass. Both of these common faults can be avoided by proper operation.

Proper mowing is an art as well as a science. Surely the operator must have skill to do a good job, but skill coupled with knowledge is the winning combination for success.

MOWING AND CULTIVATION EQUIPMENT

William Kinzer
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Jacobsen Manufacturing Company
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MOWING - Why do we Mow?

1. To Provide A Uniform Height
2. To Provide A Green Area For A Special Purpose
3. To Improve The Green Area
4. To Improve The Quality Of Grass

HOW DO WE MOW?

Several Types of Mowers:
1. Reel
2. Rotary
3. Flail
4. Sickle Bar
5. Chemicals - Growth Regulators

IMPORTANT ITEMS AS TO MOWING

1. Never Remove 1/3 Of The Leaf At Any One Mowing
2. Operate Mowing Units As Designed At Proper Ground Speed
3. Maintain Units In Adjustment
4. Maintain Sharpness At All Times
5. Avoid Mowing Wet Grass If Possible

CULTIVATION

Turf Cultivation Is A Selective Means To Till Established Turf Without Destroying The Sod Characteristics.

WHY CULTIVATE TURF?

1. To Improve The Exchange Of Air and Water and The Carbon Dioxide and Other Toxic Gasses Out Of The Soil
2. Correct Soil Compaction
3. Improve Fertilizer and Lime Usage
4. Develop A Better Quality of Grass
5. Thatch Decomposition
6. Introduce Soil Or Sand To Improve The Soil Texture
7. Overseeding and Renovation

HOW DO WE CULTIVATE?

1. Coring
2. Grooving
3. Slicing
4. Forking
5. Spiking

IMPORTANT ITEMS AS TO CULTIVATING

1. Cultivate Only During Periods Of Active Growth Of The Grass
2. Cultivate When Soil Is Of Proper Moist Content
3. Cultivate In Spring, Early Summer, And Fall
4. Normally Top Dressing Is Necessary For Areas Such As Greens

WATERING

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Water is an essential constituent of all living plants. If one harvests clippings from actively growing turf areas and makes a moisture content analysis, the results will, in general, show that water makes up 75 to 90% of the weight.

Water serves a number of critical functions in the grass plant which are listed below for review purposes.

- It is an essential part of protoplasm.
- Water functions as a solvent or catalyst for many metabolic processes.
- With carbon dioxide and energy, it is required for photosynthesis.
- It is a transport vehicle in which nutrients, organic compounds and gases enter and move through the plant.
- Water effectively moderates temperature change of protoplasm due to its high specific heat.
- It functions in cooling the grass plant and thus protects against heat injury.
- Turgidity of cells and the opening and closing of stomata are affected by water.
- It contributes to triggering the germination of seeds.

Plant-Water Relationship

Plant-water relationship was briefly enumerated above. Since some very practical and important functional factors are a consequence of water and have a bearing on you who manage turf, we would like to elaborate on these more.

Water is a strong polar solvent in which many things are dissolved. It follows then that the resulting solution is the transport medium where nutrients and organic compounds travel up and down through the grass plant. Via this function it delivers the essential ingredients around the grass plant to insure proper balance of growth assuming no other limiting forces are operating. Its movement into cells with a low water concentration provides a force for cell expansion causing growth. Further it affects the opening and closing of the stoma which controls water vapor exchange and has a cooling effect on the plant. Turgor pressure of water in cells translates to form and shape of non-woody plant parts. Water functions directly in plant chemistry in two principal reactions. Since it is a raw product of photosynthesis it provides a source of hydrogen in carbohydrates, proteins, fats, etc. In hydrolysis or digestion where sugars are split off from starch or amino acids from proteins, water molecules are added. In the buildup (synthesis) of the more complex compounds of plant structure, water molecules are split out. This touches on the complexity of water-plant relationships.

Of more practical interest is the wilt phenomena that many of you have observed in your turf areas. We mentioned transpiration briefly. This is the name for the process of loss of water by evaporation from the foliar parts of the grass plants. Via the process essential carbon dioxide enters the plant through stoma and water vapor passes out. A number of conditions may occur which upset this unique process. When soil dries, rate of water supply is affected, thus, if the rate of supply is less than loss through transpiration you see the "dry wilt" effect -

usually very visible when you walk on greens and your tracks remain. Conversely, in a "wet wilt" situation a very adequate supply of soil water may be present but some conditions such as cold soils, saturated soils, high light intensities following overcast weather can effect root permeability. In this case water uptake by the plant is impeded resulting in "wet wilt."

Another factor of practical significance in water/plant relationships is the effect of intensive mowing or low light intensity. A net result may be the imbalance in root hair formation as root growth occurs. It is thought that under these conditions limited carbohydrate is a key factor. Efficiency of water uptake is reduced. This would suggest mowing a given turf site as high as possible or improving light balance where trees are a factor in cases where turf growth lacks vigor.

Soil-Water Relationship

Since soil is the reservoir from which turf draws water, we would like to review some factors that are of interest and importance to the turf manager. The amount of water held in the soil reservoir has a bearing on the frequency and quantity of watering required. Water available to the plant is influenced by size distribution of soil pores. Turf plants use water from the soil reservoir at a rate dependent upon the amount of solar radiation and the soil water tension. Infiltration of water into soils restores water to the reservoir. Water is lost by percolation below the root zone, through removal by plants and subsequently lost in transpiration, and evaporation from the soil surface.

Let's talk briefly about water infiltration. Infiltration refers to water flow into the soil surface and differs from percolation which

refers to water flow through the soil once it has entered. The latter often is used interchangeably with hydraulic conductivity. Infiltration when plotted against time shows a rather high rate initially and decreases with time. Compacted soils, thatch, dispersed soils from salt effects, soil type (silts particularly) affect infiltration rates. As a rule of thumb, the lower limiting value on infiltration rate is used and is generally reached within half an hour after rain or irrigation starts.

Infiltration rates vary from inches per hour for sandy soils (sand greens) to tenths of inches per hour for many soils where turf is grown. On compacted soils or dispersed saline soils, the infiltration rates may drop to as low as hundredths of an inch per hour. Let's quantify a watering situation to show the magnitude of infiltration rate where it is low. If you have a turf site where infiltration rate is .1"/hour and you wish to apply 1" of water, this would require 10 hours. We indicated compaction from traffic and thatch can have a marked effect on infiltration rate. As you well know, heavy and continuous traffic on greens and its deleterious effects has been the driving force to go to the high sand content mixes. We will touch on this in more detail later.

Thatch when dry is hydrophobic or water repellent. One researcher reported that on a sloped turf site with heavy thatch, he indicated failure of water to penetrate the thatch after a 45 minute irrigation. After aerating twice, irrigation was changed from 30 minutes per day to 20 minutes every other day with improved soil wetting. Some turf managers follow a practice of cycling irrigation to contend with thatch. An initial cycle to wet thatch and then follow with subsequent cycles to

wet soils. Aerifying and spiking aid infiltration as most of you have experienced. Wetting agents or surfactants have been found to be effective in improving water intake on thatched areas and on some water repellent soils. At times the use of surfactant products are directed to treat symptoms and not causes of the basic problem. Here thatch reduction, aerification of water repellent soils, modification of soils with aggregates, or change in irrigation sprinkler or location of same may get at the cause of the problem and lessen the need to go to the surfactant product.

After water passes the soil-atmosphere interface by infiltration it moves within the soil which now is termed hydraulic conductivity or percolation. The percolation rate is a function of distance, the tension difference over that distance and soil pore cross-sectional area. In very dry soils where conducting channels are thin layers of tightly held water and cross-sectional areas are small, initial percolation of water starts at a slow rate and increases in volume with time. A plot of this in general would show a low rate at first and a later subsequent increase in contrast to infiltration rate. The plot on soils that have a tendency to swell substantially would look more like an infiltration rate plot, however. Following irrigation or rain gravitational forces move water out of the root zone. Capillary and hygroscopic tensions offset the gravitational force. The water taken up by plant roots is largely under capillary and hygroscopic tensions.

When To Water

Guidelines on when to water are influenced by a number of factors. In new seedings or where plantings are made with stolons (sprigs) and are

covered lightly, watering should be done whenever the surface of the seedbed or plant bed appears dry. Light watering (and done frequently) is a good rule of thumb to follow here. On the putting green where intensive close mowing is the rule, watering timeing should be such to avoid wilt of turf. Since the root system of turf on greens is restricted and quite shallow close attention must be given to watering. In the greens situation mid-day wilting symptoms can occur when only about half the available water is used. The turf plants generally are quite succulent and will tend to reach a permanent wilting level much faster than turf on tees, fairways, rough areas or institutional turf areas. In these latter sites, turf plants in general would have a more extensive root system as mowing heights are higher. The turf tends to be somewhat more hardened and more resistant to wilt.

In turf sites where aesthetic factors and perhaps economic factors do not require the highly manicured appearance of areas like golf greens, watering timing may be extended to provide a level of moisture to just maintain active growth without substantial loss of turf color. Many turf managers operate on a clock basis arrived at by closely observing the turf growth condition. In recent years somewhat more sophistication in watering technology has developed. From this we see substantial gains in watering efficiency. Research carried out at the South Coast Field Station of the University of California in the mid to late 1960's showed that an automatic irrigation control treatment based on soil moisture tension as monitored by tensiometers applied approximately 30" of water annually as contrasted to approximately 43" applied according to the commercial treatment based on common use among superintendents in the area.

Although we have not reached a point yet where this technology can be applied widely it does demonstrate that improved watering efficiencies

hold good potential. The use of evapotranspiration information has been quite helpful in terms of irrigation system design for different regions of the United States.

Watering Frequency

Watering frequency was discussed to some extent in the previous section. Going back a few years we find a number of research reports dealing with watering frequency. J. R. Watson, who will be speaking on this program, carried out irrigation tests in Pennsylvania some years back. He used four levels of watering: (1) rain only; (2) watered if a need was shown; (3) kept a field capacity; and (4) kept above field capacity. Treatment (1) and (2) resulted in good permanent turf while treatments (3) and (4) resulted in the invasion of weeds in the turf. We discussed above,the research in California where substantially more water was applied through more frequent irrigations based on common practice for the area versus timing watering according to soil moisture tensions tied to the irrigation control system. Little difference was noted in bermudagrass turf quality.

Evidence tends to support using evapotranspiration information to judge irrigation frequency and quantity instead of relying totally on the clock and calendar. Greens of high sand content represent exceptions and have special needs.

Water Quality

The quality of water that is used on turf areas will have a strong influence on the kind of turf produced and complexity of the maintenance program required to produce turf.

In regions where rainfall is limited, little or no leaching occurs, thus, minerals may be moved down from the surface soil but accumulate in lower soil layers, or may be returned to the soil surface by evaporation and capillary movement. Generally water available for irrigation in such

regions very likely will contain dissolved salts. The effect of dissolved salts on soil water is to make water less available for plant growth. If dissolved salts are largely calcium and magnesium sulfate, physiological injury is low. If the cation is largely sodium, soil structure is adversely affected, aeration is reduced and water relationship in the soil are affected as water cannot be effectively moved into the soil profile. Soils having much of the salts as sodium are called alkali. If anions present are bicarbonates or chlorides they may interfere with nutrition and may be toxic to the plant.

Guidelines on water quality are as follows. Good irrigation water should have a sodium absorption ratio of less than 4. Electrical conductivity (EC) is another important measure of water quality. Water with an EC of .75 mmhos/cm is about the upper limit for growing turf with no problems. Water with an EC of 2.0 is about the highest that can be used to grow crops. Water with this salt concentration requires considerable skill to grow anything. Water with a higher value than .75 mmhos/cm can be used if soil has a high infiltration rate, if an irrigation system can apply excess water at all seasons, and if good drainage is present to remove the percolate.

Soil analysis can also give valuable clues to water quality problems and should be considered along with water analysis as described above. Soil pH is most often determined in standard soil analysis. If one suspects sodium to be present, or is applied in irrigation water and finds pH to be around 9, then exchangeable sodium can be a very real hazard. Exchangeable sodium percent (ESP) is another yardstock that has value and can be obtained from the soil analysis. It is arrived at in dividing exchangeable sodium in millequivalents times 100 by

exchange capacity of soil in millequivalents. One very likely would expect an ESP exceeding 15 where soil pH's are around 9. This could lead to precipitation of calcium and magnesium as carbonates and sodium predominating in exchange sites. The sodium absorption ratio based on soil analysis in addition to the SAR of irrigation water provides further insight into potential problems. Where the SAR exceeds 18 in soil analysis then serious problems may be anticipated in maintaining turf.

To summarize water analysis should be considered a routine practice where water quality is suspected. Water analysis carried out at the beginning of the growing season can provide very helpful guidelines on managing an irrigation program. Further analysis at mid-season can provide key insight on potential problems that may be building up. This is particularly important where sewerage effluent water is being used to irrigate turf in arid regions.

Some basic guidelines that should be considered in water management in areas where water quality is a problem and sodium is the predominate factor are:

- Carefully assess if water source can be improved - blending of water from wells (if good) with sewerage effluent (where it is used). Impounded water may also offer another source in some areas.
- Maximize drainage where feasible to reduce saline percolate.
- Reduce use of highly soluble nutrient sources in fertilizer programs.
- Keep thatch layers to a minimum.
- Use excess irrigation water to leach salts.
- Follow proper guidelines on the use of gypsum.

Check with your State Extension Specialists or qualified Turf Industry Specialists if further information is required on water management problems.

PRINCIPLES OF TURFGRASS FERTILIZATION

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Turfgrass fertilization should provide adequate nutrients for the growth and development of surface conditions desired for specific purposes. This must take into account several factors that determine rates, balances, and timing of application.

I. Soil conditions on site:

- A. Existing fertility determined by soil test:
  - 1. pH
  - 2. Phosphorus
  - 3. Potash
  - 4. Calcium
  - 5. Magnesium
  - 6. Salt Complex
- B. Drainage conditions that affect nutrient retention:
  - 1. Soil texture (and organic content)
  - 2. Soil Structure
  - 3. Layering

II. Turfgrass cultivars being grown:

- A. High nitrogen requirement
- B. Low nitrogen requirement
- C. Seasonal demand

III. Use to which the turfgrass is put:

- A. Heavy duty
  - 1. Seasonal
  - 2. Year-round
- B. Scenic:
  - 1. With traffic

2. Eyeball

a. Near

b. Distant

C. Golf

1. Clippings harvested

2. Clippings not harvested

IV. Management capabilities of the user:

A. Dollars available

B. Manpower available

C. Machinery available

1. Irrigation

2. Mowing

3. Cultivation

V. Environmental factors:

A. Rainfall

1. Anticipated (soon)

2. General pattern

3. Runoff probability

B. Temperature

1. Immediate

2. Anticipated

3. Seasonal

C. Local factors

1. Trees

2. Traffic

a. Vehicles

b. People

3. Pests

a. Insects

b. Diseases

c. Weeds

VI. Interactions of all the above factors

VII. Incidental considerations:

A. Establishment vs Maintenance rates

B. Special events

C. Fertilizers available

D. Nutrient balance and minor elements

VERTICAL MOWING, AERIFICATION, AND SPIKING

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Lawns, golf courses, and other turf areas often degenerate because of compacted soil, excessive thatch build up, and mismanagement. When this happens, physical manipulation of the sod is often required to restore its vitality. Unlike conventional farm crops which can be plowed, turf areas must be physically manipulated so that the surface is opened up without destroying its appearance (aesthetic value). How can this be done? For example, how can a turf manager till a golf green to a depth of three inches and leave the surface in good putting condition? It is done with specialized equipment invented by ingenuous men like Tom Mascaro.

Vertical mowing, coring, and spiking are methods of tilling intact turfgrass sod to improve the growing conditions within the thatch layer or on the soil immediately below the surface. Each practice requires highly specialized equipment.

I. Vertical Mowing

The vertical mower cuts by impact of whirling knives, which turn in a vertical plane on a high speed horizontal shaft. These blades are usually fixed, rather than free-swinging. They vary in thickness from 1/32" to 1/4". The thinner blades are used on golf greens, where the surface must not be drastically disturbed. The interval of space between blades on the shaft can be varied. The spacing interval is determined

by the desired effect and the horsepower of the engine on the unit. Power requirements for vertical mowing are 2x to 3x that required for reel mowing.

Originally, the vertical mower was a hand operated unit with a cutting head 18" to 22" in width. It was used at monthly or seasonal intervals to cut vertically into the sod and lift out a large portion of the thatch layer. This practice was largely limited to golf greens and was accomplished by setting the height of cut so the blades sliced about 1/4" into the soil. To see this practice performed, made one wonder about the sanity of the Superintendent. A once-over with the vertical mower and the green looked as though a professional football scrimmage had been held on it. The resulting putting surface reminded one of an old fashioned rub board used for laundering clothes before the advent of washing machines. The practice was ultimately good for the grass, because it (1) partially eliminated the excess thatch layer, (2) cut and often removed old stolons,(3) interrupted "grain" patterns, and (4) promoted growth of many new shoots.

In some situations today, it may be necessary to set the vertical mower to cut deeply into the turf. This will groove the putting green, therefore the surface should be soil topdressed immediately to counteract the roughened surface and cover exposed stolons.

With the advent of the riding triplex greens mower, came multiple head vertical mowing units, which are interchangeable with the cutting reels. This arrangement enabled the turf manager to vertical mow the greens very rapidly and to simultaneously collect the clippings. The latter had previously necessitated that a vacuum or sweeper be passed over the greens following vertical mowing.

It is now a recommended practice to vertical mow golf greens at weekly intervals when the turf is in its best season of growth. The cutting blades should be set to only nick the grass surface so that the putting quality of the green is not impaired.

In summary, we can say that routine vertical mowing of golf greens will improve the playing surface by:

(1) Truing the putting surface through removing "grain" and by making the superintendent more aware of any uneveness existing in the putting surface. The latter can be eliminated through skillful soil topdressings.

(2) Stimulating new shoot development and removing old and worn stolons.

(3) Removal of some thatch.

(4) Breaking up surface crusting on bare or thin-turfed areas.

In addition, the vertical mower is useful at the time of overseeding bermudagrass greens with winter grasses. Greens to be overseeded should be vertical mowed in 2 or 3 directions just prior to seeding. This vertical mowing should be more severe than routinely used during the warm months. It will (1) retard the growth of the bermudagrass, thus reducing competition for the seedlings of the overseeded grass, (2) open the turf somewhat for better penetration of the overseeded grass, and (3) true the putting surface.

Vertical mowing is not totally beneficial to turfs. It definitely encourages more weeds, and if the height of cut is too low, it will weaken the turf and lower the putting quality. Vertical mowing should be avoided during periods when growth of the grass is slow due to season, disease, or other stress factors.

Vertical mowing of larger turf areas is accomplished with tractor drawn vertical mowing units which operate on the PTO. Such units usually

have large blades which are set to groove the turf to the soil surface or deeper. The main purpose of this type of vertical mowing is to remove thatch and to stimulate "sod bound" turf to grow more vigourously. Using the vertical mower once a year to dethatch hybrid bermuda fairways or gridirons is a common practice. Where fairways are overseeded each fall, the ideal time to vertical mow is just prior to overseeding.

II. Aerification

Aerification may be defined as the removal of small soil cores or plugs from turf areas, leaving a hole or cavity in the sod. Such holes aid in the movements of air, water, nutrients, nematicides, and other compounds into and through the upper portion of the soil. Machines for coring turf have hollow tines or open spoons about 3" in length, which are 3/8" to 1" in diameter. Soil cores brought to the surface may be removed or crushed and worked back into the thatch layer. When worked into the sod, the soil intermingles with the thatch layer and aids in its biological decomposition. This is one of the most effective ways to control excessive thatch build-up.

Aerification is most beneficial on soils high in silt or clay and on highly compacted soils. The frequency of aerification needed depends on the degree of soil compactions. Golf greens and tees and gridirons need more frequent aerification than less trafficked areas. In general, turf responds to aerification best in spring and late summer. Generally two aerifications annually are adequate for intensely used turf areas.

Machines are also available for slicing or pressing holes in the soil without removal of soil. Slicing is less effective than coring but it can be done much faster and is often more practical for large turf areas. Most slicing machines have blades shaped like those on a sickle bar mower. These

blades are bolted at intervals on the perimeter of metal wheels spaced about 6" to 1' apart on a long axle. As the wheels turn, the blade slices into the turf, cutting a narrow slit 3" to 5" deep and about 1/8" wide. Such openings do not interfere with the use of the turf.

It is best to irrigate the turf immediately after slicing or coring to prevent excessive drying of turf at the edge of the openings made by the blades or tines.

If the soil on which the turf is growing were "ideal" in physical make-up, it is doubtful if aerification would even be needed. However, such ideal soil mixture is rarely attained, hence, aerification should be a standard practice on most turf areas receiving regular traffic, whether foot or vehicular.

III. Spiking

Spiking is a variation of "slicing". Spiking is accomplished by forcing the small solid teeth of metal discs into the soil surface to a depth of 1/2" to 2". A typical hand guided spiking machine has about 20 disc shaped blades which have teeth-like rowels on a spur. Wider units or tandem groups of smaller spikers are available for use on large turf areas. The spiker does not remove a soil core, so in essence, may compact the soil in the same manner as the cleat on a golfer's shoe. For this reason, the practice of "spiking" turf areas is controversial. Some golf course Superintendents spike greens weekly throughout the year, while other Superintendents never use it.

The spiker is most often used on bermudagrass golf greens in late winter or early spring on the theory that many small holes promote early emergence of bermudagrass. This theory is not supported by hard data.

In fact, since cold air is more dense, spiking may enhance penetration of cold air into the turf, thereby, delaying emergence of the bermudagrass.

The spiker is very useful in breaking up surface crusting of thatch and algae scum. Since a single pass of spiker creates about 10 to 20 thousand holes per 1,000 square feet, it is effective in helping to "dry-out" poorly drained turf areas. It also helps alleviate compaction. Where such conditions exist on golf courses or gridirons, spiking is a very beneficial practice.

TOP-DRESSING FOR TURF

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Any serious discussion of "Principles of Turf Management" would be most incomplete without giving consideration to such a basic principle as topdressing. With the lack of manpower during World War II, we found that we could get along without it. Improperly done, it can add to our problems and essentially destroy a well constructed green of otherwise excellent quality. Apply too much and we smother the grass. If we fail to sterilize topdressing components we plant weeds and very likely encourage disease. There are other potential disadvantages too numerous to mention so why don't we just close the book on topdressing and forget it. We don't because ever since man began managing turf and improving it for sports use, the many advantages have been obvious although not often understood.

Topdressing is the turf industry's castor oil. It is a bitter medcine to take but it certainly does a lot of good things for us.

Many of the advantages of topdressing are spelled out in an article by Mr. William H. Bengeyfield, entitled "Top-Dress Greens and see the Difference", published in the Green Section Record in January 1969.

Mr. Bengeyfield lists the advantages as (1) smoother putting surfaces, (2) tighter and finer textured turf, (3) reduced grain, (4) an aid to thatch decomposition, (5) reduced disease, (6) better water and fertilizer infiltration, (7) alleviation of compaction, and (8) protection against cold weather injury.

In addition to these advantages we might suggest at least two beneficial uses of topdressing as (1) soil modification and (2) as a seed-

bed for winter grasses on bermuda greens.

These beneficial or useful aspects of topdressing place the subject in an entirely different light. Still, there are a great many valid questions left unanswered about the materials to use and how best to apply them in addition to the basic question about the need for topdressing at all. At this point, I can only rely on the propondrance of research information which favors topdressing and my own practical experience and observations which also favor the practice.

I am not going to tell you that you can't do without topdressing because too many people have proven they can. I also won't tell you that topdressing is worth the manpower and expense it takes to do it because it may not be in your case. But I will tell you that the best putting greens are topdressed frequently and that poor greens can be improved with a properly analyzed topdressing material.

In preparing this talk, I found well over 75 references to some aspect of topdressing published by noted authorities. This probably isn't an original thought and it isn't the first time the thought has occurred to me, but it would appear that you can support the positive or the negative side of almost any turf question with published references by turf authorities.

One reference published in 1970 said, "topdressing is usually not necessary." Suitable turf grasses will thrive without it. However, there are a few special situations where topdressing may be warranted (because of the labor and expense involved, topdressing should be limited to the most important turf areas). This isn't a complete shutout because the door is left open to some topdressing in special situations and beside, it refers more to parks, lawns and athletic fields than to putting greens. On the other hand, the entire reference tends more to down grade

the benefits of topdressing than to promote them. Perhaps this particular reference is a little too far removed from our real subject to be applicable, however, we can start there and move on to a reference published in 1973 which says, "Topdressing should not be used as a routine practice in the cultural system but only as needed to control thatch or to improve the smoothness of a green surface. The frequency of topdressing varies from none to as frequently as every 3 to 4 weeks. Quality bentgrass greens have been maintained for years without topdressing, while topdressing may be a necessary cultural practice on other greens."

The most recent reference is an article in the May 1974 issue of the Green Section Record by Madison, Paul and Davis of the University of California. The article is entitled, "Consider a New Management Program for Greens." This article outlines some advantages of and procedures for light frequent topdressings. Basically, they are talking about topdressing 15 to 20 times a year depending on such variables as the section of the country, the management the turf receives, and the type of grass being grown.

Now, who are you going to believe and which practice should you follow? All of these references are correct if taken in their proper context and if followed advisedly. What a turf manager must do is learn the basic principles behind topdressing, use these with a definite purpose in mind and adjust the topdressing schedule according to the needs of his individual situation.

Now, let us go into some basic facts about topdressing and its use:

1. Topdressing Material and Layering

The material used as a topdressing must be a properly analyzed product which would be suitable for use in green construction. Specifications for such a material are clearly and definitely outlined in the

U.S.G.A. "Specifications for Putting Green Construction" and in the recently published article, "Sand For Golf Courses." There is no way to achieve the best result from topdressing greens with a material of lesser quality.

Roots move with great difficulty, if at all, from a clay soil having small pores into a sandy soil having large pores. For various reasons, most of which were erroneous, people have tried to improve what they termed a poor sand or "peanut soil" by topdressing with what was supposed to be a rich, black, fertile "woods soil" or "good loam." What they achieved was a beautiful layer which held moisture at the surface of the soil and destroyed the capillary continuity of the entire topsoil. From such misguided applications as this, a real fear of layering was deeply ingrained into the turf industry and became one of the first things a turf student or manager learned to avoid like the plague.

So firmly is this dread of layering entrenched in the minds of the majority of turf managers, which probably includes a great many in the audience, that what I say probably won't do much to change your mind, but I am going to try.

A good topdressing material (properly analyzed) can eventually modify or replace the poor soil to a depth which is adequate to give your green a new lease on life and provide a manageable situation.

Although we would prefer to have the entire topsoil on a green uniform in depth, this is seldom possible unless the right soil was used in construction and its use was continued as topdressing.

Dr. Marvin Ferguson has said that, "Much of the controlability of traffic on putting greens is either built in at the time of construction or it is left out." The same goes for manageability. We may be able to

improve a poor soil with topdressing to the point where we can live with it but we can never make it as good as it would have been if properly constructed in the first place.

Faced with a poor green we can sometimes improve the manageability of that green by purposely layering it to our advantage. This will work in almost every case except where the original soil is so bad that it won't grow roots under any circumstances.

A compaction resistant soil with adequate drainage as well as adequate moisture retention, such as would be the product of a proper physical analysis according to U.S.G.A specifications, when placed as topdressing over a tight clay, typical of most older greens, would make an almost immediate improvement in the growth of the turf.

This, or almost any other soil which is more porous than the clay but has within itself adequate moisture retention for turf growth, would improve the green and continue to make it better so long as the porous soil remains on the surface. The layering problem begins only when we cover the porous soil on top with a less porous material.

Because of research at Purdue University, we now know that pure sand with a modifier such as peat in the top few inches for moisture retention will make an excellent putting green soil. This type of porous material over a tight soil such as clay gives good infiltration of moisture into the soil down to the clay thus providing a desirable dryness on the surface with abundant moisture in the rootzone. Surface compaction will be alleviated and a type of surface drainage will be achieved. Of course, the deeper the layer of good soil, the better, but in numerous situations like this (a loose soil on top and a clay underneath) we have seen bentgrass roots strong and healthy below 12 inches. The tops were good too. In this

case, layering has distinct advantages.

2. How Much Topdressing and Why

The amount of topdressing required will vary with each situation; soil modification taking the most and a normal topdressing for thatch and grain control taking the least.

In my opinion, topdressing should always be done so that it is incorporated with or naturally blends with the thatch. Simply covering a layer of thatch, especially a heavy layer of more than 1/2 inch, would have about the same effect as installing one of those bad layers we are all so afraid of.

To properly mix the topdressing with the thatch we must either topdress frequently enough to keep the thatch from getting ahead of us, as Madison suggests, or we must mechanically remove the thatch by aeration, filling the holes with good topdressing; or remove the thatch by slicing and filling the groves with topdressing.

Mixing the thatch with topsoil encourages microbiological activity which in turn breaks down thatch and converts it into valuable soil humus. In addition, new soil around the grass plant will cover stems causing them to take root and send out new shoots thereby producing a tighter, finer-textured turf with less grain. Last, but not least, repeated topdressing will smooth and true the putting surface; ball marks, footprints, damaged areas and all, and help to keep it putting better.

Exactly how much topdressing to use should be redetermined for each application and will vary with such things as type of grass, temperature, purpose of the topdressing, and condition of the grass on the putting surface. A handy figure to remember is that it takes 1.54 (roughly one and one-half) cubic yards of topsoil to cover 1,000 sq.ft., 1/2 inch deep. To figure other depths or volumes required, simply multiply for greater depths and divide for less.

In most cases, 1/5 (.2) of a cubic yard per 1,000 sq. ft. is considered a very light topdressing. This is one cubic yard on an average 5.000 sq. ft. green. This would figure out to about 1/16 of an inch of topdressing over the entire green. When using a heavier topdressing, possibly before overseeding, 2 to 3 cubic yards per 5,000 sq. ft. green might be used to prepare a good seedbed and to aid in protecting the bermuda stolons and rhysomes through the coming winter.

Most topdressing is sold by the ton but it is impossible to do more than roughly estimate quantity unless you know how much a cubic yard of the material weighs. In Virginia we have a topdressing supplier who uses a light weight aggregate (expanded shale) in place of sand and one ton of this product offers about half again as much by volume as a ton of most of the competitive materials. To make the most of your budget, don't forget this angle in buying topdressing materials and always figure the quantity if the materials offered are comparable in price per ton and quality. That last item, quality, is a real clencher though. Bad materials can be worse than none at all which is another way of saying that the real bargains are measured by quality and a car-load of poor topdressing soil can be worth less than one cubic yard of properly mixed material toward putting green improvement. A reputable dealer with a good product will always be happy to furnish you with the results of the physical analysis of his material. Without such an analysis, which can be reconfirmed by subsequent testing, you would do well to steer clear of the material.

Also, to fully analyze the situation, don't forget to figure how much it will cost to make your own topdressing. In most cases, however, it is just as expensive or more so to make your own than to purchase a good premixed material.

3. Preparation, Handling, and Application of Materials

We don't have time to cover preparation of topdressing in detail but let it suffice to say that you should select the best materials available and have them physically analyzed. The raw materials should be accurately mixed in the proportions specified by physical analysis and screened to remove all undesireable objects and fractions of the materials itself.

The final step in preparation is sterilization which can be done in many ways such as composting or with chemicals such as methyl bromide or Vapam. However you do it, this is an important step that should never be omitted.

Proper handling of topdressing materials means that they will be stored in a place that will keep them uncontaminated and dry; ready for use at anytime. Polyethylene covers are sometimes used in the absence of better storage facilities but these leave a lot to be desired.

Getting the prepared topdressing from the storage area to the green efficiently and economically can be another problem unless you use a little ingenuity. Now days, the topdressing is almost always put out by machine and the machine should have a constant supply once the job is begun until it is completed.

A good operation has only three steps, (1) load into truck, (2) transport, (3) load topdressing machine from truck. In many efficient operations, the topdressing is never touched by human hands. It is loaded into the truck with a bucket loader, transported and unloaded directly into the topdressing machine. Unloading the truck is done by dumping a spreaderful at a time through what amounts to something like a coal chute.

Laying down topdressing with a machine is much more uniform than the old method of shoveling it on, even so, the soil should be thoroughly

smoothed into place and evened up. Smoothing is best accomplished with a power drag mat going over the green several times. The object is to remove soil from high spots and deposit it in the depressions to obtain a smooth and true surface. Following the drag mat operation the new soil should be further settled into place by a light watering.

The advantages of a good topdressing are many and where the finest quality putting greens are desired, this practice is a must. In my opinion, the merits of topdressing have been adequately proven although there are still a great many unanswered questions about when, how, and why we should do it; what it does for the turf, and especially what constitutes a good material. Studies going on here at Texas A&M and at other research centers will help us find some answers.

TURF INSECTS

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SUCKING INSECTS

Southern Chinch Bug, *Blissus insularis* Barber

Description: Adult chinch bugs are 1/6 to 1/5 inch long, have a black body, reddish-yellow legs and fully developed wings, which lie flat against the back. Each front wing is mostly white but has an irregular black patch at the middle of the outer margin. The newly hatched nymphs (young) are bright red with a whitish band across the back. With each successive molt, the young darken and more nearly resemble adults, but have no wings.

Life history: Chinch bugs overwinter as adults in many sheltered areas near or in lawns. In the spring, adults emerge and lay eggs, which hatch in a few days into tiny nymphs. The nymphal stage lasts about 30 days, and the life cycle is completed within 7 to 8 weeks.

Damage: Chinch bugs have piercing-sucking mouthparts and feed by sucking plant fluids. Damage first appears as small, wilted areas which soon become yellow or brown. These areas increase in size as the insect population increases and as chinch bugs move from damaged or dead plants to healthy ones. Early symptoms of infestation may be confused with several lawn diseases and other problems. Chinch bug infestations can be diagnosed accurately only if the insects are observed. Damage is most common on St. Augustine lawns. Common bermudagrass is seldom attacked.

When damage is severe and bugs are plentiful, they usually can be found by spreading the grass and carefully observing the soil surface. When yellow or brown patches of grass are first noticed, a large coffee can or gallon can

with both ends removed can be used to determine if chinch bugs are responsible. Press one end of the can 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 in several different locations. Careful observation is required to see the small numphs.

Bermudagrass Mites, *Aceria neocynodonis* Keifer

Description. Bermudagrass mites are microscopic, eight-legged pests which cause considerable damage to bermudagrass lawns. These cigar-shaped mites differ from those commonly seen around the home. They are oblong and white, whereas many common mites are oval and reddish.

Life History. Bermudagrass mites multiply rapidly and cause severe damage in a short time. The females lay eggs in protected sites on the plant. Immature mites hatching from eggs are six-legged larvae. They then become nymphs with eight legs, as have adults. The life cycle is complete in about 1 week.

Damage. Bermudagrass mites suck juices from grass stems and leaves, resulting in yellowed or browned areas and a generally unhealthy appearance. Stunted internodes, causing the grass to look bushy, are characteristic of injury. When mite damage is severe, grass is severely thinnned and weeds usually replace dead grass. Bermudagrass is the preferred host.

Rhodesgrass Scale, *Antonina graminis* (Maskell)

Description. Adults are about 1/8 inch in diameter, globular, dark purplish brown and covered with a felted, white, cottony secretion. The oblong, oval, cream-colored first instar larvae or crawlers move about but become sedentary following the first molt. The sac-like second instar

larvae insert their sucking mouthparts into the plant and lose their legs, appendages and antennae. They secrete a waxy covering for protection.

Life History. All Rhodesgrass scales are females. They give birth to living young for a period of about 50 days. Newly born larvae remain on the body of the female under the waxy covering for several hours, then emerge from the sac, become very active and run over the plant in search of a feeding site.

The larvae wedge themselves beneath a leaf sheath at a node or in the crown of the host, insert the mouthparts and begin their immobile existence. The felted waxy sac covering is secreted at this time.

The life cycle requires about 50 to 60 days and there are five generations annually. Reproduction continues throughout the winter in southern Texas.

Damage. Adults and nymphs damage lawns by attacking plant crowns, causing infested plants to turn brown and die.

Rhodesgrass scale attacks bermudagrass and St. Augustine grass in South Texas.

Bermudagrass Scale, *Odonaspis ruthae* Kotinsky

Description. Adults are about 1/16 inch long, oval, covered with a white, hard, waxy secretion and having sucking mouthparts.

Damage. This insect infests bermudagrass and is especially active in shady areas. It kills grass, causing bare, brown patches.

Ground Pearls, *Margarodes spp.*

Description and Life History. The female adult secretes a white, waxy sac in which she places about 100 pinkish-white eggs. Slender nymphs hatch and feed on fine grass rootlets. Nymphs cover themselves with hard globular shells resembling tiny pearls. They are about 1/8 inch in diameter.

Damage. Ground pearls sometimes seriously damage bermudagrass in the South and Southwest, and centipede grass in the South. Attacked grass turns brown in summer and dies in fall, leaving irregular dead spots.

Leafhoppers, Family *Cicadellidae*

Description. Leafhoppers are wedge-shaped, frequently mottled insects that fly or hop when disturbed. They are less than 1/5 inch long and are green, yellow or brownish gray.

Life History. Most species overwinter as adults; a few overwinter in the egg or nymphal stage. Eggs are inserted into the tissue of the host plant. These hatch in 5 to 14 days and produce nymphs which resemble the adults except in size and the presence of wings. There are commonly from one to four generations annually.

Damage. Many species of leafhoppers infest lawns, sucking sap from grass leaves and stems. New lawns may be damaged so extensively that reseeding is necessary. Damage to established lawns is generally negligible unless the lawn also suffers from moisture or fertilizer deficiencies.

Chiggers, *Trombicula spp.*

Description. These are the familiar red-colored mites that are so troublesome. The small, red adults may be seen traveling slowly over the surface of the ground. The females die soon after depositing their eggs in soil. The active feeding stage or first instar larvæ has three pairs of legs, is reddish and small enough to be difficult to see.

Life History. Eggs laid by the female hatch into immature chiggers called larvae. Only the larvae are parasitic on man and animals. Larvae transform into nymphs and the nymphs into adults. Nymphs and adults feed on insect eggs, small insects and other organisms found on or near woody decaying substances. The adult of the common chigger spends the winter in an

earthen cell, about 1 to 1-1/2 inches deep in the soil.

Damage. Chiggers do not damage grass but are pests to animals and human beings. On warm-blooded animals, larvae search for a suitable location to feed. They prefer parts of the body where clothing fits tightly or where flesh is thin, tender or wrinkled.

Chiggers insert their mouthparts into the skin and then inject a fluid (enzyme) which liquefies the tissue. This fluid causes reddish welts, swelling, itching and fever in sensitive individuals.

A chigger attached in a pore or at the base of a hair may be so enveloped in swollen skin that it appears to be burrowing into the skin. But chiggers do not embed themselves in skin.

When suffering from chigger bites, take a bath as soon as possible; then apply antiseptic to each of the welts. This kills any chiggers not killed or removed by the bath, and it helps prevent infection. Destroying chiggers reduced itching but does not stop it. Fluid injected by the chigger causes itching. No practical way to remove chiggers has been found, and no treatment is known that will give permanent relief from itching.

Chewing Insects

Sod Webworms, *Crambus spp.*

Description. Sod webworms are the larvae of lawn moths. Adults are small, whitish or gray moths with a snout-like projection in front of the head. Wings are folded closely about the body when at rest. The larvae or sod webworms are about 3/4 inch long, slender and light brown with dark spots.

Life History. Lawn moths hide in shrubbery or other sheltered spots during the day. In early evening, they fly over the lawn and the females scatter eggs. The eggs hatch in about 1 week, and the larvae begin feeding. These insects remain larvae for 3 to 4 weeks, then pupate. Adults appear

about 1 week later. A life cycle is completed in 5 to 6 weeks, with several generations within a year. They overwinter in the soil as larvae in silkin webs.

Damage. The newly-hatched larvae feed on grass and, as they grow, build burrows or tunnels slightly below the soil surface. They cut off blades of grass, drag them into the burrows and eat them. Sod webworms feed only at night, remaining in their silken webs during the day.

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

Extremely close observation is required to detect larvae in lawns. Sod webworms can be detected by examining the grass at the soil surface for webbing. These larvae also can be found by breaking apart some of the drying sod. If there are three or four larvae within a 6-inch square section, an insecticide treatment is recommended.

Fall Armyworms, *Spodoptera frugiperda* (Smith)

Description. The adult is an ash-gray moth. Its forewings are mottled with irregular, white or light-gray spots near the extreme tip. Forewings of the female are much duller than those of the male. Hindwings of both sexes are white with a narrow, smoky-brown edge. When expanded, the wings are about 1-1/2 inches across.

Newly hatched larvae are white with black heads. Their bodies darken as they feed until they are full grown. Full-grown larvae are about 1-1/2 inches long. Their color ranges from light green to almost black with several light stripes along the body. The front of the head is marked with an inverted white "Y".

Life History. After mating, female moths lay their eggs at night on leaves of grass. Eggs are laid in masses of 50 to several hundred, and they hatch into larvae in 2 to 4 days.

During growth, they may curl up in leaf sheaths, suspend themselves from plants by threads or move about on the ground. Fall armyworm larvae complete their feeding in 2 to 3 weeks. Then they burrow an inch or two into the soil, make small cells and pupate. In 10 days to 2 weeks, the moths emerge. The fall armyworm may have as many as six generations a year.

Damage. The fall armyworm is one of the most destructive insects to lawn grasses in certain years, particularly bermudagrass. Most severe outbreaks usually occur following a cold, wet spring.

Young larvae feed on the lower surfaces of leaves, leaving the epidermis intact. At first they eat only tender parts of leaves. Later, as they grow, they devour all foliage except plant stems. Damage at first may appear as whitish patches in the lawn where the grass has been skeletonized.

Fall armyworm larvae feed mostly at night, concealing themselves under plant foliage during the day. If forced by hunger to seek other food, they may migrate in the daytime. The larvae may attack and devour one another when crowded or migrating.

Armyworms, *Pseudaletia unipuncta* (Haworth)

Description. The adult of the armyworm is a moth. It is brownish gray with a small, white spot near the center of each front wing. When expanded, wings are about 1-1/2 inches across.

Young larvae are pale green and loop when crawling until about half grown. Full-grown larvae are smooth, striped, almost hairless and about

1-1/2 inches long. Usually, they are greenish having one stripe along each side and a broad stripe down the center of the back; stripes are dark and often nearly black. The middle stripe usually has a fine, light-colored, broken stripe down its center. The body between the dark stripes ranges from greenish brown to reddish brown. The head is greenish brown and is finely mottled with darker brown spots.

Life History. After mating, female moths lay their eggs at night in folded leaves or under leaf sheaths of grains and grasses. They prefer moist or shady spots for egg laying.

Larvae complete their feeding in 3 to 4 weeks. Then they burrow under litter on the ground, under clods or 2 to 3 inches into the soil. There they make small cells and change into pupae.

The armyworm usually has three broods each year. It overwinters in the larval stage or sometimes in the pupal stage. In South Texas, all stages of the insect may be present during winter. Mild, dry winters followed by cool springs are favorable for its survival and development.

Damage. Damage to lawns caused by armyworms is similar to that caused by fall armyworms, but is usually not so severe.

White Grubs, Family *Scarabaeidae*

Description. White grubs are the larvae of several species of May or June beetles. They are white or gray, have a brown 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 in the ground; some remain 2 or 3 years. In mild weather, they live 1 to 3 inches below the soil surface, while in winter they move deeper.

Damage. White grubs burrow about an inch below the soil surface and feed on grass roots. Damage appears as areas of dead, dry grass. Grass in infested areas can be lifted out of the soil very easily or rolled back into a mat of runners and foliage. Grubs often can be found between this mat and the soil.

Mole Crickets, *Scapteriscus spp.* and *Gryllotalpa spp.*

Description and Damage. Mole crickets can be recognized by their broad, shovel-like front legs. With these legs, mole crickets burrow into moist, light soils for food. This burrowing often results in the roots of plants being severed and seedling plants uprooted. Newly seeded lawns are especially susceptible.

INSECTS: Control

Successful control of any pest involves a management program irregardless of the commodity involved. This is true of turfgrass the same as with field crops, fruit orchards, animals, household and many others. Probably the most important phase of insect control relates to its biology. In order to cope with any pest one should have a thorough knowledge of the insect's biology. Practically all insects have a weak link during its life cycle that makes it vulnerable to some type of control measure which may require applications of pesticides or the use of cultural methods. Timing of the use of either of these two methods of approach is a very important factor, even more so than the choice of the chemical to be used.

One must be aware of various factors responsible for or favor pest outbreaks and he should strive to remove or avoid these factors prior to the onset. Management practices include cultural, habitat modification, use of resistant or less susceptible varieties, or even mechanical destruction of pests. Insecticidal treatments should be made when absolutely necessary and use only approved chemicals for the specific problem involved. Frequently insecticides are applied that result in damaging effects by being ineffective to the target pest as well as causing a decrease in populations of beneficial non-target insects which otherwise would have been invaluable as predators and/or parasites.

People concerned with the control of pests of lawns and other ornamental plants usually are not as money-conscious per unit treated as are those engaged in crop production. Consequently we are prone to accept the old adage, "If a little bit will do a little good, a whole lot will do a great deal more good". Regardless of the ultimate gain to be expected we should be cognizant of the following:

(1) Most pesticides are toxic to non-target as well as target pests. Even, human lives may be at stake.

(2) Residue hazards may result from drift or run-off to adjoining areas, Not only is this a hazard in regards to the owner and/or applicator but he is liable for any harm to his neighbors and especially pets. Proper choice of the method of application, ie. sprays, dusts, granules, baits, etc. often minimizes these hazards.

(3) Overdosages and frequency of insecticide treatments often result in pest-resistance and such practices should be discouraged.

(4) Use of approved and recommended pesticides. This phase usually is solved by carefully reading the label on the package or container and following instructions. However, frequently a particular insecticide labelled for use to control a specific insect is very effective but may result in a buildup of heavy population of mites or other insect. Consequently in order to control the pest species involved a mixture of two or more insecticides (or insecticide - fungicide mixtures) may be required.

Organisms inhabiting an ecological environment of "Turfgrass" which consists of a complex of parts of leaves, stems and roots of the grass plants are diverse. Most of these pests, ie. chinch bugs, armyworms, white grubs, et al. are well known. However, turfgrass is also inhabited by nonpests, such as beneficial insects, mites and nematodes which comprise a complex that interact with the plant and thatch as well as with other pest organisms. Streu (1973) reported finding more than 100 different organisms within a specific grass area. Let us not lose sight that many of these very small mites, insects and nematodes are predaceous or parasitic on some of the species of harmful insects to which we apply pesticides for control. Therefore, we should be aware of excessive amounts and frequency of applications of pesticides to any specific area.

CHEMICAL CONTROL

(For rates, read and follow directions on labels.)
The list of chemicals herein may be incomplete and/or some included are currently approved but may not have a use label in the future.

Armyworms & Cutworms	Chlordane, Diazinon, Carbaryl
Ground pearls	No chemical control
Cricket (Mole)	Chlordane, Carbaryl, Malathion, Toxaphene
Earwigs	Chlordane, Carbaryl, Commercially prepared baits
Chinch bugs	Aspon, Carbophenothion, Diazinon, Ethion
Leafhoppers	Aspon, Carbophenothion, Diazinon, Ethion, Carbaryl
Sod webworm	Carbaryl, Chlordane, Toxaphene
Pillbugs and Sowbugs	Carbaryl, Chlordane, Lindane, Commercially prepared baits
Snails and Slugs	Carbaryl, Commercially prepared baits
Chiggers (Redbugs)	Treat premises with Chlordane, Sulfur, Lindane, Toxaphene
White Grubs (Larvae of May Beetles)	Chlordane, Diazinon
Grass Mites	Sulfur, Carbophenothion, Diazinon, Ethion, Dicofol (Kelthane), Dimethoate, Malathion, Chlorobenzilate
Ants	Chlordane, Diazinon, Baygon. Mirex for fire ants, town ants and leaf-cutting ants.

References

Adkisson, P. L. 1974. Selection of insecticides for use in integrated control programs. Special Rept., Dept. Entomol. Texas A&M University. 3 p.

Almand, L. K. and J. G. Thomas. Insects and related pests attacking lawns and ornamental plants. Texas Agri. Ext. Serv., B-1078. pp. 2-6.

Reinert, J. A. and S. H. Kerr. 1973. Bionomics and control of lawn chinch bugs. Bull. Entomol. Soc. Amer. 19(2):91-92.

Steu, H. T. 1973. The turfgrass ecosystem: Impact of pesticides. Bull. Entomol. Soc. Amer. 19(2):89-91.

TURF DISEASES

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Brown Patch Disease (fungus - *Rhizoctonia solani*): Occurs in in the late spring or early fall. The disease is characterized by circular patterns of dead grass blades in the turf. These range from 1 to 50 feet in diameter. Blades and sheaths are pulled easily from the stolons because of deterioration in the attachment area. Stolons often remain green. New leaves may emerge in the center of the circular patch in two or three weeks giving the diseased area a doughnut shaped appearance. The entire spot eventually may become green during a long growing season. Disease development occurs most rapidly in temperatures between 75 and 85 degrees F when free moisture is present. Fungus activity stops when the air temperature reaches 90 degrees. This explains seasonal development. Some lawns are affected almost every year, while others are damaged only occasionally. Fungicide application should be made when brown patch is expected. On lawns where brown patch occurs occasionally, apply fungicide when the disease first appears. (See chapter on Chemical Control for specific recommendations.)

Gray Leaf Spot (fungus - *Piricularia grisea*): Gray leaf spot causes irregular brown to gray spots on leaf blades of St. Augustine grass. In areas of heavy disease development, the grass may have a burned or scorched appearance resulting from death or spotting of the leaf blades. The leaf spots are often diamond shape. Lesions also occur on stems

and spikes of affected plants. This disease develops rapidly with abundant moisture and warm temperatures. It is usually noticed first in shaded areas that remain damp for some time. Control is best accomplished by avoiding excessive nitrogen fertilization. Water during the early part of the day. Most turf fungicides control this disease effectively. (See Fungicide Chart.)

Helminthosporium Leaf Spot (fungus - *Helminthosporium sp.*): Symptoms of this fungal disease appear as irregular patches ranging in size from two to several feet in diameter. Infections on leaves appear as small, olive green spots which enlarge to form dark blotches. Infected leaves die and fade to a light tan color. The entire plant is killed when the root rot phase of this disease develops. The disease-causing fungus overwinters in thatch at the base of the plant and acts as a pathogen when weather conditions favor its development during the growing season. Chemical fungicides are effective in control. (See the fungicide Chart for specific recommendations.)

Fading-out (fungi - *Curvularia sp.*): Fading-out is a serious problem in many lawns where the grass thins and becomes unsightly. This condition develops more rapidly during the summer when large dead areas appear in the turf. Fading-out is most prevalent on grass weakened by other disease-causing organisms, insect pests, nematodes or improper cultural practices. Effective control of fading-out requires several different approaches. The first is to correct cultural conditions that limit plant growth. Mowing at the proper height, fertilizing according to soil test, watering properly and avoiding thatch build-up all contribute to healthy grass that resists development of weak pathogens. Fungicide applications hasten recovery of affected turf. However,

they should be used in combination with good cultural practices.

Fairy Rings (fungi - *Marasimus sp., Agaricus sp., Chlorophyllum sp.*): Mushrooms in a circle or semi-circle are called "fairy rings". Mushrooms are fruiting structures of fungi produced when weather conditions are favorable. Mushroom-producing fungi develop an organic matter in the soil and produce fruiting structures on the outer limits of the colony causing a circular effect. Grass is often greener in the ring area because of available nutrients liberated by decomposition of the fungus. Grass in the center of the ring may be declining because of fungus activity. Warm, wet weather enhances this disease. Control often is not necessary because of the condition's temporary nature. In other cases, however, the affected grass may decline rapidly if corrective steps are not taken. These steps are to aerate the soil by punching holes 6-8 inches deep at regular intervals. Then, apply a fungicide drench at a strength 2 or 3 times stronger than the normal recommendation.

Dollar Spot - Small Brown Patch (fungus - *Sclerotinia homeocarpa*): The disease appears as round, brown or bleached spots the size of a silver dollar or slightly larger. Lesions may be seen on the edges of leaf blades. These cause death of leaf tips. During disease activity, fungal growth appearing like fine cobweb growth, may be present on leaf blades in early morning dew. This disease can occur any time during the year but it is most prevalent in late spring or early fall along with hot, humid days and cool nights. Improved bermudagrass, zoysia and bahiagrass are the most severely affected grasses grown in Texas. Control is accomplished by applying adequate nitrogen and spraying with a turf fungicide if the disease occurs. (See Fungicide Chart.)

Pythium Blight (fungi - *Pythium aphanidermatum*): Affects improved bermudagrasses. Infected grass rapidly dies in spots or streaks. In early stages of infection, the affected spots may have a "cottony" appearance due to the abundant fungal growth. The disease occurs during warm, humid weather in poorly drained areas. Fungicides are effective for control. (See Chemical Control.)

Slime Molds (fungi - *Physarum and Fuligo sp.*): The most common slime mold found on turf grass occurs as a dark gray to black crust-like material. The soot-type material rubs off easily on shoes or clothing. Slime molds derive nourishment from decaying organic matter in or on the soil. Under certain conditions, they move upward on sticks, stones, grass blades, etc., to produce spores. They do not feed on green plants and cause no damage other than shading. Slime molds develop during warm, humid weather. Remove from lawn grass by applying water under pressure with a water hose or by brushing with a broom.

Smut (fungus - *Ustilago sp.*): Occurs on both St. Augustine grass and bermudagrass. Smut galls replace the seed in the spike. The inflorescence generally is distorted. This disease is more of a nuisance than a threat to turf health. Control usually is directed toward preventing seed head development. Adequate watering and fertilization helps prevent seed head development which occurs under stress conditions. Close mowing may remove seed heads when produced.

Rust (fungi - *Puccinia sp.*): Plants affected with rust have a chlorotic appearance, and stands may begin to thin. Orange-colored linear pustules or raised bumps are evident on leaf blades. These vary in appearance, depending on the species involved. Pustules are difficult

to see on affected St. Augustine grass unless the blades are examined with a hand lens. Zoysiagrass is affected more than either St. Augustine or bermudagrass. Rust is most damaging during mild, warm weather. Rust diseases can be controlled by using fungicides.

Nematode (Nematode - Many sp.): Symptons often appear as areas of low fertility, even where fertilizers have been applied. This occurs when nematodes feeding on roots reduce their ability to absorb water and nutrients. Where nematodes constitute the limiting growth factor, a nematicide application usually is needed yearly. Good cultural and fertilization practices also help overcome nematode injury. (See chapter on Nematodes for additional information.)

St. Augustine Decline - SAD(virus): In early disease infection stages, leaves show a chlorotic mottling. The mottling or mosaic symptom becomes progressively more severe until a chlorotic appearance is observed. In later stages of disease development the grass is weakened, leaves and stolons begin to die and invading grasses and weeds crowd out the weakened St. Augustine grass. Plant a resistant variety - Floratam. (See addendum on Disease Resistance.)

Other Problem Causes

Soil compaction - Certain soils are compacted easily, especially in areas of heavy foot traffic. This condition prevents adequate penetration of moisture and nutrients and restricts root system growth. Several types of aerafiers correct this condition.

Dog Urine injury - Circular spots 8 to 10 inches in diameter may appear

in areas frequented by female dogs. Heavy watering helps correct this condition.

Fertilizer burn - Commercial fertilizers are salts and can burn grass when applied excessively. This condition is most often seen where fertilizers were spilled.

Excessive shading - Most lawn grasses require rather high light intensities. When a lawn is fertilized, this in turn stimulates growth of shrubs and trees that shade the grass. Selective pruning of trees and shrubs helps correct this condition.

Sun scald - Clipping grass too closely removes foliage necessary for food manufacturing and exposes stolons to direct sun rays. When this occurs, a brown lesion or burned area is found on the upper surface of the stolon. Avoid mowing too closely.

Improper fertilization - Excessive use of an individual element, such as nitrogen, makes plants more susceptible to disease attack. Avoid this problem by fertilizing according to soil test recommendations.

Shock - Allowing grass to become too tall before mowing causes grass to experience shock and lose vigor. Mow frequently to prevent this condition.

Permanent wilt - Grass allowed to become too dry may pass the permanent wilt stage where recovery is not possible. This may occur where water does not penetrate because of compaction.

Diseases	Suggested Material(s) (%Active)	Application Information: Rate (Active Ingredient)	Application Information: Intervals	Application Information: Min. Days to Harvest	Remarks
LAWNS					
Brown Patch	benomyl (50% WP) -Tersan 1991 -Benlate	1.25 lb/A 0.5 oz/1,000 sq. ft.	10-14		Begin at first sign of dryness
	PCNB (35 and 75% WP, 2lbs/gal E.C.) -Terraclor	.75 to 1.0 lb/ 1,000 sq.ft.			Apply when needed
	zinc-ion maneb (80% WP) -Fore	3.2 to 6.4 oz/ 1,000 sq.ft.	7		Must be applied on regular schedule to be effective.
	chlorothalonil (75% WP) -Daconil 2787	1.5 to 6.0 oz/ 1,000 sq.ft.	7		Must be applied on regular schedule to be effective
	cyclohexamide + PCNB -Actidone RT	.065 oz. + 3.75 oz/3500 sq.ft.	7-14		Must be applied on regular schedule to be effective
Helmintho-sporium Leaf Spot	zinc-ion maneb (80% WP) -Fore	same as Brown Patch	7		2 to 3 applications may be required
	chlorothalonil (75% WP) -Daconil 2787	same as Brown Patch	7		2 to 3 applications may be required
	-Dyrene (50% WP)	.125 to .250 lb/1,000 sq.ft.	1 to 2 weeks		Multiple applications may be required
Grayleaf Spot	zinc-ion maneb complex (80%) WP) -Fore	same as Brown Patch	7		2 to 3 applications may be required
	chlorothalonil (75% WP) -Daconil 2787	same as Brown Patch	7		2 to 3 applications

Diseases	Suggested Material(s) (%Active)	Application Information: Rate (Active Ingredient)	Application Information: Intervals	Application Information: Min. Days to Harvest	Remarks
LAWNS (continued)					
Grayleaf Spot (continued)	-Dyrene(50% WP)	same as Helminthosporium leaf spot	7		2 to 3 applications
Dollar Spot	benomyl(50% WP) -Benlate	same as Brown Patch	10-14		Multiple applications may be required
	chlorothalonil (75% WP) -Daconil 2787	same as Brown Patch	7		2 to 3 applications
	-Dyrene (50% WP)	same as Helminthosporium leaf spot	7		2 to 3 applications
Pythium Blight	chloroneb (65% WP) -Tersan SP	2.6 oz/1,000 sq.ft.	5-7		Multiple applications may be required
	-Dexon(70%WP)	1.4 to 1.8 oz/ 1,000 sq.ft.			
	terrazole (35% WP) -Koban -Truban	1.4 to 2.8 oz/ 1,000 sq.ft.	5-10		
Rust	zinc-ion maneb (80% WP) -Fore	same as Brown Patch			2 to 3 applications
Fading Out	zinc-ion maneb (80% WP) -Fore	same as Brown Patch	7-14		2 to 3 applications
	captan (50% WP -Captan -Orthocide	1.6 oz/1,000 sq.ft.	7-14		

WEED CONTROL IN TURF

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A vigorous turf is the best control for weeds. Broadleaved weeds and weedy grasses usually are not a problem when a well-adapted turfgrass is properly established, fertilized, mowed and watered. A thin, weak stand of grass will be invaded by weeds. Killing weeds with chemicals will not keep them out unless followed by lawn management practices that encourage the grass to grow vigorously enough to compete with the weeds.

Regular, frequent mowing controls many common turf weeds, but chemical herbicides are effective and are suggested for use in many turf weed situations.

Effective and safe use of these is dependent on a number of considerations: (1) identification of the weed or weeds to be controlled, (2) selection of an approved herbicide that is effective on such weeds, (3) giving consideration to its safety in relation to possible damage to the turfgrass, trees, shrubs and other palnts, (4) application at the proper rate, time and method, and (5) observing label precautions for use.

Chemicals to control weeds after growth has begun, should be applied when weeds are immature and growing rapidly. Treatments usually will not be effective when applied to weeds that are maturing or growing slowly because of drought or approaching maturity. Those chemicals suggested for pre-emergence control of weeds must be applied before the annual weeds germinate and begin growth.

Trade names included in this section are not intended as endorsement of the product of a specific manufacturer, nor is there any implication that any other formulation containing the same active chemical is not equally as effective. Trade names are included solely to aid readers of this publication in locating and identifying the herbicides recommended.

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
TURF, HOME LAWNS					
		POSTEMERGENCE CONTROL			
Broadleaved weeds including clover, chickweed, dandelion dichondra, dock, henbit, oxalis, plantain, wild carrot, wild onion and garlic, spotted spurge, and shepherds-purse	Dacamine Turf Herbicide 1.5 oz. of 2 lb/gal product	2,4-D amine 0.37 oz.	2 gal.	Fall and early Spring	Caution on Tifdwarf and Tifgreen bermudagrasses, Do not use on St. Augustine and centipedegrass.
	Chipco Turf Herbicide D 0.75 oz. of 4 lb/gal product	2,4-D amine 0.37 oz.	2 gal.	Same as above	Same as above
	MCPP or MCPA 2.0 oz. of 2 lb/gal product	MCPP or MCPA 0.5 oz.	2 gal.	Same as above	Same as above
	Chipco Turf Kleen 4.0 oz. of 1 lb/gal product of 2,4-D and MCPP	2,4-D amine and MCPP 0.75 oz.	2 gal.	Same as above	Same as above

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Broadleaved weeds (continued)	Buctril or Nu-Lawn Weeder 0.75 oz. of 2 lb/gal product or 3.0 oz of 0.5 lb/gal product	Bromoxynil 0.2 oz.	2 gal.	Same as above	May be used on all Turfgrasses
Cool season grassy weeds including Poa annua, rescuegrass, little barley, ryegrass	KERB-50 W 0.75 oz. of 50% wettable powder	Pronamide 0.37 oz.	2-3 gal.	Fall	Use only on bermuda-grass turf
	Phytar 560 10 oz. of 2.48 lb/gal product	Cacodylic Acid 3.0 oz.	3-5 gal.	Apply only to Dormant bermudagrass	Kills broadleaved and grassy weeds. Dormant bermuda recovers in early spring. Do not use on bluegrass or St. Augustine.Do not apply after turf greens-up in Spring.
	Endothal Turf Herbicide 2.0 oz. of 2 lb/gal product	Endothall 0.55 oz.	3-5 gal.	Same as above	Same as above
Warm season grassy weeds including crab grass, goosegrass, dallisgrass, nut-grass, and sandbur	Organic arsenicals	DSMA, MSMA, AMA, CMA, at 1 oz.	3-5 gal.	Spring and Early summer	Do not use on carpet, St. Augustine or Centipede grasses. Repeat application in 7 to 10 days

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Poison Ivy Poison Oak	Silvex Spot treat as directed on label	Silvex	Wet Foliage	Spring and summer	Follow label recommendations
	Ammate X or Ortho Brush Killer A Spot treat as directed on label	Ammonium Sulfamate	Wet Foliage	Spring and summer	Do not spray desirable foliage
		PRE-EMERGENCE WEED CONTROL			
Control of Poa annua, crabgrass, goosegrass, rescuegrass, little barley, ryegrass and others.*	Balan 3 lbs. of 2.5% granular	Benefin 1.2 oz.	Dry	Prior to weed emergence Feb. 15 - Mar. 15. for warm season weeds September 1-15 for cool season weeds	May be used on established warm season turf grasses.
	Dacthal W-75 5.3 oz. of 75% product	DCPA 4 oz.	2-3 gal.	Same as above	Same as above
	Dacthal 10 lbs. of 2.5% granular	DCPA 4 oz.	Dry	Same as above	Same as above

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Pre-emergence (continued)	Betasan 3.6G 6.4 lbs. of 3.6% granular	Bensulide 3.7 oz.	2-3 gal.	Same as above	Same as above
	KERB 50 W 0.75 oz. of 50% wettable powder	Pronamide 0.37 oz.	2-3 gal.	Same as above	Use only on bermuda-grass
	Azak 5G 4.6 lbs. of 5% granular	Terbutol 3.7 oz.	Dry	Same as above	Established warm season turfgrasses
	Enide 50 W 3.0 oz. of 50% product	Diphenamid 1.5 oz.	2-3 gal.	Same as above	Same as above
	Tupersan 50 WP 9.0 oz. product	Siduron 4.5 oz.	2-3 gal.	Spring	For use on bluegrass and fescue only. Apply 0.5 inches water within 48 hours of application.

*Check label for specific weeds controlled by the herbicide

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
TURF, PREPLANT WEED CONTROL					
Control of all grassy and broadleaved plants including bermudagrass	Dowfume MC-2 1-2 lbs. product per 100 sq. ft.	Methyl Bromide 1-2 lbs. per 100 sq. ft.	Gas	When grass and weeds are actively growing and soil is moist	Must be applied under polyethylene cover. Leave cover in place 48 hours. Do not apply over the root zone of desirable trees and shrubs. Poisonous Gas. Follow manufacturers directions.
	Vapam 1 qt. of 4 lb/gal product per 100 sq. ft.	SMDC 1 lb. per 100 sq. ft.	1 gallon per 100 sq.ft.	Same as above	Area to be treated should be irrigated prior to treatment. Water thoroughly after treatment. Do not apply within 3 ft. of drip line of desirable trees and shrubs. Follow label Directions.
	Dowpon 6.0 oz. of 74% dry product	Dalapon 4.6 oz.	5 gallons	Spring and summer	Must wait 6 weeks after treatment before planting turfgrasses. Do no apply within 3 ft. of drip line of desirable trees and shrubs.

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Grassy and broadleaved including bermudagrass (con't)	Phytar 560 10 oz. of 2.48 lbs/gal product	Cacodylic acid 3 oz.	4 gallons	Spring and summer	Repeat application in 10-14 days for bermudagrass control. Temperature should be above 80°F for best results.
TURF, FAIRWAYS, ATHLETIC FIELDS, PARKS AND OTHER LARGE TURF AREAS					
		SAME AS FOR LAWNS WITH THESE ADDITIONS			
Postemergence control of broadleaved weeds	Banvel 0.75 oz. of 4 lb/gal product	Dicamba 0.37 oz.	2 gallons	Spring and Fall	Caution on Tifdwarf bermudagrass and St. Augustine grass.
	Trimec Trex-San 1.0 oz. of product	2,4-D MCPP and Dicamba	2 gallons	Spring and Fall	Same as above
	Ferti-lome Broad Spectrum Weed Killer 2.5 oz of product	2,4-D and Dicamba	5 gallons	Spring and Fall	Same as above

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
TURF, GOLF GREENS (BERMUDAGRASS)					
Postemerge control of broadleaved weeds	2,4-D amine 0.25 - 0.50 oz. 4 lb/gal product	2,4-D amine 0.12 - 0.25 oz.	2 gal.	Fall and Early spring	Use light rate on Tifdwarf. Repeat applications at 7-10 days if light rates are used
	MCPP or MCPA 0.50 - 1.0 oz. of 2 lb/gal product	MCPP or MCPA 0.12-0.25 oz.	2 gal.	Same as above	Same as above
	Banvel 0.1 - 0.2 oz. 4 lb/gal product	Dicamba 0.05 - 0.10 oz.	2 gal.	Same as above	Same as above
	Trimec or Trex-San 0.5 - 1.0 oz. product	2,4-D MCPP and	2 gal.	Same as above	Same as above

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Postemerge control of broadleaved weeds (con't)	Buctril or Nu-Lawn Weeder 0.5 oz. of 2 lb/gal product	Bromoxynil 0.12 oz.	2 gal.	Same as above	May be used on newly overseeded greens.
	Cominations of 2,4-D, MCPP, MCPA, Dicamba, and Bromoxynil may be used as directed on label.				
Postemerge control of grassy weeds	MSMA or DSMA 1-1.5 oz of 4 lb/gal product	MSMA or DSMA 0.5-0.75 oz.	1-2 gal.	Summer	Repeat applications at 7 to 10 day intervals.
Preemerge weed control	Use only if recommended on label for Bermudagrass Golf Greens.				
TURF, GOLF GREENS (BENTGRASS)					
Postemerge control of broadleaved weeds	Trimec or Trex-San for bent grass 0.5-1.0 oz. of product	2,4-D MCPP and Dicamba	2 gal.	Spring and fall	Best to use low rates and repeat applications in 10-14 days if necessary
	MCPP or MCPA 0.5 oz. of 2 lb/gal product	MCPP or MCPA	2 gal.	Same as above	Same as above
	Buctril or Nu-Lawn Weeder 0.5oz. of 2 lb/gal product	Bromoxynil	2 gal.	Same as above	Same as above

Weeds controlled	Product and Product rate per 1,000 sq.ft.	Herbicide common name rate per 1,000 sq.ft. active ingredient	Spray Volume per 1,000 sq.ft.	Time to apply	Remarks
Pre-emerge control of Poa annua	Pre-san 9 0z. of 4 lb/gal product	Bensulide	5 gal.	Pre-emerge	Use only on established turf
Postemerge control of bermudagrass in bentgrass greens	Tupersan 6 to 9 oz. of 50% product	Siduron	3-5 gal.	Spring and Fall	Apply only to Seaside, Penncross, C-1, C-7, and C-19 bentgrass. Apply ½ inch of water within 3 days after treatment.
TURF, SOD PRODUCTION					
SAME AS FOR FAIRWAYS, ATHLETIC FIELDS, PARKS AND OTHER LARGE TURF AREAS WITH THESE ADDITIONS					
Pre- and early post-emerge control of broadleaved and annual grassy weeds	Aatrex 80 W 1-1.5 oz. of product	Atrazine	2 gal.	Early spring and Fall	Use on St. Augustine, centipede and zoysia (except Midwest zoysia). Add surfactant for postemerge weed control.
	Princep 80 W 1-1.5 oz. product	Simazine	2 gal.	Pre-emergence	Use on St. Augustine, centipede and zoysia (except Midwest zoysia).

PARTIAL LIST OF TURF WEED CONTROL HERBICIDES*

COMMON NAME	TRADE NAMES (Partial list)
1. 2,4-D Amine	Decamine Turf Herbicide; Weedar 64; Chipco Turf Herbicide D, Numerous mixtures with MCPP and/or dicamba
2. Mecoprop (MCPP) or MCPA	Mecopex; Chem Weed-265; Chiptox; Numerous mixtures with 2,4-D and/or dicamba
3. Silvex	Ortho Chickweed and Clover Killer; Weedone 2, 4, 5 - TP; Numerous mixtures with 2,4-D
4. Dicamba	Banvel; Dow Dicamba Herbicide; Numerous mixtures with 2,4-D and/or MCPP
5. Bromoxynil	Buctril; Nu-Lawn Weeder; Some mixtures with MCPA
6. Endothall	Endothal Ferti-lome, Green Light and Sears Clover, Winter-grass and Weed Killer
7. Organic Arsenicals (MSMA, DSMA, CMA, AMA)	Ansar 529; Ansar 8100; Methar; Ortho Crabgrass Killer; Daconate; Super Dal-E-Rad; Super Crab-E-Rad
8. Atrazine	Aatrex; Bonus-S, and in other fertilizer mixtures
9. Simazine	Princep; Fertilizer mixtures
10. DCPA	Dacthal; Ferti-lome Crabgrass and Weed Preventer; Acme Garden Weed Preventer; Weed and Feed Combinations
11. Benefin	Balan; Ralston Purina Crabgrass Kill; Weed and Feed Combinations
12. Bensulide	Betasan; Prefar; Presan; Weed and Feed Combinations
13. Terbutol	Azak; Weed and Feed Combinations
14. Kerb	Kerb 50-W
15. Siduron	Tupersan; Weedone Pre-emergence Crabgrass Control
16. Cacodylic Acid	Phytar; Chem Trim; Rad-E-Cate 25; Contax
17. Dalapon	Dowpon

* Carfully follow all label directions for use of each herbicide.
Note: The information given herein is for educational purposes only. Reference to commercial products or trade names is made with the understanding that no discrimination is intended and no endorsement by the Cooperative Extension Service is implied.

PARTIAL LIST OF TURF WEEDS AND SUGGESTED CHEMICAL CONTROLS

COMMON NAME	SCIENTIFIC NAME	CHEMICAL CONTROL*
Aster	Aster exilis	3, 4, 8
Betony	Stachys sieboldii	3, 4, 8
Bindweed	Convolvulus arvensis	1, 2, 3, 4
Black medic	Medicago lupulina	2, 3, 4, 6, 8
Burclover	Medicago hispida	1, 2, 3, 4, 6, 8
Carpet burweed	Soliva nasturtiifolia	1, 2, 4, 5, 8
Chickweed	Stellaria media	2, 3, 4, 6, 7, 8, 10, 11
Cudweed	Gnaphalium spp.	1, 3, 4, 8
Dandelion	Taraxacum officinale	1, 2, 3, 4, 8
Dichondra (Ponyfoot)	Dichondra spp.	1, 2, 3, 4, 6, 8
Dock	Rumex crispus	1, 2, 3, 4
Evening primrose	Oenothera spp.	1, 3, 4
Goathead (Puncturevine)	Tribulus terrestris	1, 3, 4
Henbit	Lamium amplexicaule	3, 4, 5, 6, 12
Mallow	Malva neglecta	2, 3, 4
Mat chafflower	Alternanthera peploides	3, 4
Matchweed	Lippia nodiflora	3, 4, 8
Nightshade	Solanum spp.	3, 4, 5
Oxalis (Yellow woodsorrel)	Oxalis stricta	2, 3, 4, 7, 8
Pennywort	Hydrocotyle spp.	1, 3
Pepperweed	Lepidium spp.	1, 2, 3, 4, 5, 6
Plantain	Plantago spp.	1, 2, 3
Poison ivy	Rhus spp.	3
Poison oak	Rhus spp.	3
Prostrate knotweed	Polygonum aviculare	2, 3, 4, 5, 11

PARTIAL LIST OF TURF WEEDS AND SUGGESTED CHEMICAL CONTROLS

COMMON NAME	SCIENTIFIC NAME	CHEMICAL CONTROL*
Prostrate pigweed	Amaranthus spp.	1, 4, 5, 8, 9
Purslane	Portulaca oleracea	3, 4, 8, 9, 10, 11
Shepherd's purse	Capsella bursa - pastoris	1, 2, 3, 4, 5, 6
Sow thistle	Sonchus oleraceus	1, 2, 3, 4, 6
Spurge, spotted	Euphorbia supina	2, 3, 4, 5, 8, 10
Whiteclover	Trifolium repens	2, 3, 4, 6
Wild carrot	Daucus carota	1, 2, 3, 4
Wild onion & garlic	Allium spp.	1, 4
Annual bluegrass	Poa annua	6, 8, 9, 10, 11, 12, 13, 14, 16
Bahiagrass	Paspalum notatum	7
Bermudagrass	Cynodon dactylon	15, 17
Bur bristlegrass	Setaria verticillata	10, 11, 12, 16
Carpetgrass	Axonopus affinis	7
Centipedegrass	Eremochloa ophiuroides	7
Crabgrass	Digitaria spp.	7, 8, 9, 10, 11, 12, 13, 14, 15
Dallisgrass	Paspalum dilatatum	7
Goosegrass	Eleusine indica	7, 8, 9, 10, 11, 12, 13, 15
Little barley	Hordeum pusillum	6, 8, 9, 10, 11, 12, 16
Purple nutsedge (Nutgrass)	Cyperus rotundus	7, 16
Rescuegrass	Bromus catharticus	6, 8, 9, 10, 11, 12, 13, 14, 16
Ryegrass	Lolium multiflorum	6, 8, 9, 10, 11, 12, 13, 14, 16
Sandbur	Cenchrus spp.	7, 8, 9, 11

PARTIAL LIST OF TURF WEEDS AND SUGGESTED CHEMICAL CONTROLS

COMMON NAME	SCIENTIFIC NAME	CHEMICAL CONTROL*
Sedge, prostrate	Cyperus spp.	7
St. Augustinegrass	Stenotaphrum secundatum	7
Smutgrass	Sporobolus poiretii	17

* Numbers refer to herbicides listed on following table.

CONSERVATION, QUALITY CONTROL AND BEAUTIFICATION IN TURF OPERATIONS

MAINTENANCE IN TODAY'S ECONOMY

J. R. Watson
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In this era of changing life styles, increased attention is being focused on how we spend our leisure time, particularly leisure time spent close to home due to reductions in travel. One consequence of these changes has been more intensive use of turfgrass areas and facilities, and increasingly we hear rumbles about minimum to zero maintenance for turfgrass, diversion of the special purpose fertilizers from turfgrass to food production and to the elimination of useful pesticides.

And, sometimes, perhaps too often, I am afraid we in the turfgrass field become entangled in the vicissitudes and cross currents of local, national and international political problems, as well as social and socio-economic issues and in that climate we may forget that turfgrass plays a vital role in the health and well-being of our nation.

For the functional and aesthetic roles and values of turfgrass fill a very basic need of a people caught up in the maelstrom and humdrum of caring for themselves and a large portion of the worlds' needy and hungry - an impossible task on a continuing basis for one nation-regardless of how economically strong that country might be.

I trust that we readily recognize the recreational aspects and values of turfgrass. For these and for other reasons, we must, in my opinion, maintain and expand our turfgrass facilities.

All of us involved in the turfgrass industry - the turfgrass managers, university and industry research and extension personnel, service groups

(USGA Green Section, National Golf Foundation), manufacturers and suppliers - must assume a major share of the burden in developing new concepts and the new ideas that will be required for the maintenance and management of turfgrass facilities in spite of conflicting regimes.

This professional group must lead the fight to ensure that the tools, in the form of fertilizers, pesticides, equipment and other supplies so sorely needed by the turfgrass managers are not taken away.

This must be done in total harmony with reasonable, sensible environmental and ecological concepts and programs despite soaring prices and costs of operating our turf facilities.

MINIMUM MAINTENANCE

How do we manage with today's economy? What about minimum maintenance? If we assume that our current maintenance level is "standard" or "optimum" then minimum maintenance could become "reduced maintenance." Something less than what is currently deemed desirable.

If we assume that "minimum maintenance" means performing only the minimum number of jobs, for example mowing, required to keep the area in suitable condition, then we must abandon the concept of a "level of maintenance" and be content with what soon would become very poor quality turf.

Personally, I cannot accept either of these concepts. I prefer the concept of minimum cost with maximum results. I believe that "minimum maintenance" must assume the maintenance of our turfgrass facilities comparable to or above their current quality level.

I believe that minimum maintenance in today's economy demands a careful examination of all financial and managerial areas and a review of all cultural practices. It is to these areas that I will address

my remarks.

Equipment and people are two concerns that come immediately to mind when the topic of financial management of turf facilities is raised.

Certainly, efficient maintenance demands the use of equipment that will cut more acres per day per man. It means equipment with greater capacity, more durability and longer life. Such equipment is complex and requires a higher level of training for the mechanics who service such equipment. Thus, the training of operators and mechanics becomes a vital and necessary step to ensure maximum results with minimum expenditures.

A second area in equipment utilization involves planning and supervision. Planning for the most efficient way to use the equipment and to keep it operating. About the turn of the century Frederic Taylor made intensive studies of industrial operations and concluded that anywhere from ten to fifty percent of a man's day may be spent in idleness or non-productive work. Interestingly enough, roughly two thirds of that idle time is the result of inadequate supervision. Initiating methods to correct this situation provides a challenge for all turf facility managers and supervisors. It also emphasizes the basic reason why the manager of a turf facility must carefully study all aspects of the work to be done and ensure proper and adequate supervision.

CREW MOTIVATION

Another area involving people relates to the motivation of your workmen. There are ten points involved in supervisory responsibilities

that some authorities believe essential for harmony and maximum productiveness from workmen. They are:

1. Build employee job satisfaction

   ...not job-happy, but job-satisfied

2. Provide development and growth chances for employees

   ...develop individual talents - point toward promotion based on leadership abilities, skill and knowledge of of the job function, not salary or the basis of seniority

3. Treat employees with complete fairness

   ...be consistent, be impartial

4. Cultivate an atmosphere conducive to productive work

   ...efficient, business-like, but pleasant - good comaraderie - good fellowship - take crew on a picnic or a fishing trip

5. Deal effectively with all gripes and grievances, regardless of how insignificant they may seem

   ...handle these situations promptly and completely no matter how simple you may think the problem to be - remember it is very important to your employee

6. Protect employees' physical well-being

   ...check on safety aspects - daily health habits - OSHA and similar organizations are demanding compliance

7. Develop employees

   ...through training in the latest maintenance techniques, coaching, motivating, and persoanl supervision

8. Promote upward communication

   ...listen to gripes, grievances as well as suggestions- involve the crew individually and collectively in performance and job critiques

9. Promote downward communication

   ...pass on all company factual data pertinent to employees and work - also compliments on jobs well done - possibly even a reward system for employee suggestions concerning cash saving maintenance methods

10. Take personal interest in employee

Labor and crew relationships play a vital role in attacking the largest single budgetary item - labor; hence, offer an opportunity to attain maximum results with reduced expenditures. It is estimated that labor represents approximately 70 percent of the maintenance budgets on golf courses and other turf facilities. These labor costs have been at this percentage level for some thirty to forty years. The number of people employed has dropped from twenty-five or thirty to ten or twelve. Yet, today turf facilities have a better quality turf than at any time in the past - and they are used more heavily and more intensively.

Improved maintenance equipment has certainly been one of the reasons. Knowledge gleaned from research and from experience and disseminated by many individuals and organizations has contributed substantially. Turfgrass conferences as well as regional and national get-togethers have also resulted in substantial improvement in turf quality.

But if we are to maintain and improve the quality levels of our turf areas in the face of the current economic environment, it seems to me there is a need to carefully review all aspects of turfgrass care and management not only from a current operating standpoint but also from a very basic standpoint. In this respect I will briefly outline the basic cultural practices associated with turfgrass management.

Turfgrass production has been defined as the product of three major factors:

1. The grass adapted to the prevailing climate and environment and suitable for the play and use conditons for which the turf area is grown.
2. A soil to support the growth requirements of the grass and modified to meet the requirements of play and use. Modification of physical properties is desirable only on intensively used

sites whereas chemical properties must be modified on all sites to balance the nutrient requirements of the grass against the inherent nutrient supplies of the soil.

3. Cultural practices

CULTURAL PRACTICES

The cultural practices applied to turfgrass are the same irrespective of the type of turf area or its location. In point of fact from a basic standpoint they are the same as those applied to forage and pasture areas. They vary in the degree of intensity with which they are applied and in the timing of their application. For example, a putting green requires more frequent watering, mowing, fertilization and pest control measures than does a fairway, a park area or a cemetery plot; yet, all these cultural practices are necessary on each area. Similarly the timing of these cultural techniques on cool and warm season grass areas varies in accordance with the temperature response of each group of grass.

The cultural practices are presented in outline form with minimum comment.

1. Watering: How much, when and how applied.
2. Fertilization: Base application of phosphorous and potash needs on soil test, adjust pH, select and apply nitrogen based on the form (soluble or organic) and in accordance with growth and color needs.
3. Cultivation: Cultivate (topdress, aerify, spike) to alleviate compacted or crusted soil condition, to improve water penetration and avoid runoff.
4. Mowing: Height of cut suitable for type of play and other use

conditions, frequency - a function of height of cut in that the area should be mowed often enough so that no more than one third of leaf surface is removed at any one cutting. In today's economy, height of cut should be raised to maximum tolerated by players or users. Use sharp well adjusted equipment and study the sequence or routes of travel between cutting areas to arrive at maximum efficiency. Select large capacity equipment whenever possible.

5. Programs to control pests, thatch and soil compaction.

Pests

a. Disease. Recognize that disease producing organisms are universally present, that turfgrass is a host for the organism and that where environmental conditions (particularly temperature and moisture) are optimum for growth of the organisms, disease will result. Identify the disease and select the appropriate fungicide.

b. Insects. Identify nature of feeding habit - a root or leaf feeder. Know life cycle, choose the appropriate insecticide and apply it in accordance with the feeding habit of the insect.

c. Weeds. Broadleaf versus grassy types. Choose the appropriate herbicide and apply it in accordance with manufacturers recommendations. Select pre- or post- emergence material based on type of weed, type of turf and time of year.

Thatch

Develop thatch prevention programs then eliminate the condition and control it by (a) mechanical means (verti-cutting lightly, combing, and good mowing practices), (b) chemical means (adjust fertilization practices) and (c) biological means (topdressing).

Soil Compaction

Cultivate when the grass is growing most actively, modify soil when possible - use material of a textural size that prevents compaction (sand), adjust traffic patterns, or, if a school ground or campus, place sidewalks of adequate capacity where students have developed paths.

SUMMARY

Maintenance of turfgrass in today's economy demands a careful review of all managerial responsibilities. Especially crucial are those items relating to budget control, personnel matters and turfgrass cultural practices. No organization should miss the opportunity to review and study these phases of their operation and all turfgrass managers should accept the challenge of producing comparable or better turfgrass in spite of today's economic difficulties.

WATER MANAGEMENT

K. W. Brown
Associate Professor
Soil & Crop Sciences
Texas A&M University

In the past, water has often been readily available and could be used on golf courses indiscriminately. As water becomes more expensive and concern for the environment becomes greater, there is need to take a closer look at water management to see if systems can be developed to make more efficient use of the available water without jeopardizing the playing surface.

Let's take a quick look at what happens to water we put on. It could be used by the grass as evapotranspiration, or it could be lost by leaching or runoff. The amount of water required for well-watered turf grass to supply the evapotranspiration needs is regulated almost entirely by the weather. The height of the grass or the frequency of moving has little effect on water use. On a clear hot day, as much as 3/8 of an inch of water will be used for evapotranspiration. The amount lost on a cloudy warm day will be only about 10% of the 3/8 of an inch lost on a clear hot day. The amount of sunshine is the predominant factor in determining evaporative loss.

Runoff wastes water and fertilizer and should be minimized. In certain cases where the infiltration rate of the soil is low, it may be desirable to terrace certain parts of the fairway to minimize runoff. Irrigation rates should be set low enough so that they do not exceed the infiltration rate. If a system exists that puts on water quicker than the soil can absorb it, one useful approach is to irrigate more frequently with smaller amounts. This allows the water to reach drier soil and take advantage of the higher infiltration rates which occur at the beginning of

each water application.

Loss of water by leaching may be either desirable or undesirable depending on the characteristics of the water applied. If the water is nearly free of salts, there is little need to put on enough water to cause leaching. If the water contains large amounts of salts, however, as is characteristic of many supplies in Texas, periodic over applications are needed to wash the salts out of the soil profile to prevent them from injuring soil or the grass. As shown in Figure 1, a layer of water one foot thick with 2500 ppm salt will add 3.4 tons of salt per acre. In many areas of the state, where rainfall is sufficient to cause periodic leaching, the problem of salt build-ups is automatically solved. This is particularly true in areas where much of the rain falls in a short period of the year. Often a flushing once or twice a year is sufficient. It is a good policy to know how much salt is in your irrigation water. If your utilities people can't tell you, send a sample to the soil test lab of the Texas Agricultural Extension Service, through your county agent.

Such flushing, of course, also causes the loss of nutrients, particularly nitrogen in the form of nitrates. Thus either slow release fertilizers should be used or frequent samll applications (1/2 lb./1,000 sq. ft.) of soluble fertilizer should be used.

Excess leaching causes not only water and nutrient loss, but may also cause an increasing water table below the golf course. In low lying areas where salt is a problem, this can be particularly detrimental. If the water table rises too close to the surface, the salts will accumulate in the root zone as the water moves up from below. Efforts to remove the salts by adding more water only intensify

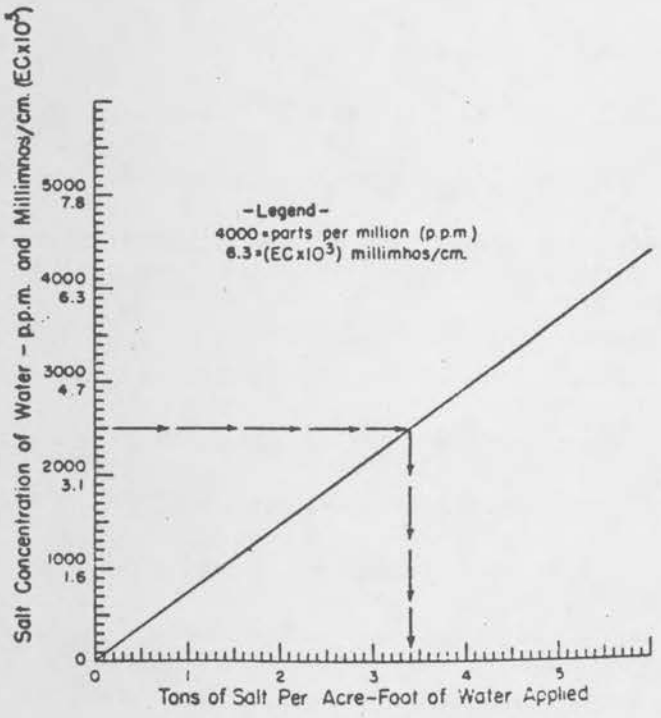


Figure 1. Effect of irrigation water quality on salt deposition in the soil. As shown above, water containing 2,500 parts per million will deposit 3.4 tons of salt per acre-foot of water applied.

the problem by adding more salt and increasing the water table height. The best solution to such a problem is to avoid over irrigation in the first place. If the problem of a high water table already exists or if one wishes to avoid water table build-ups, drain tile should be installed under low areas. Proper drainage is essential if salts are to be leached from the soil.

SPECIAL SOIL CONSIDERATIONS

The golf course superintendent has a somewhat complicated irrigation problem in that the soil moisture (see Table 1) characteristics may differ greatly between the greens and the fairways. Irrigation systems should be designed to allow different irrigation scheduling on the different soils on the golf course.

The ability of soils to infiltrate and store water varies greatly. A clay may have an infiltration rate as low as 0.5 inch per hour while a golf green containing 85% sand may have an infiltration rate of 8 inches per hour. The clay may be able to hold two inches of water per foot between free drainage and the wilting point while the sand may be able to hold less than one inch per foot. Also, in properly constructed golf greens the large pores in the gravel prevent water from moving out of the top mixture.

Caution must be taken however, that sand mixtures are not placed directly on soils of finer texture since the small pores in the clay or loam will quickly suck the water out of the sand mixture and cause the grass to suffer water stress. The situation often develops around the edge of a golf green where the sand mixture which should be over the gravel overlaps the original top

Table 1. Typical values of available water and infiltration rate for soils that may be found on a golf course.

Soil Texture	Available Water Inches per foot	Infiltration Inches per hour
Clays	2.4	0.5
Clay Loams	2.1	1.0
Loams	1.8	1.5
Fine Sandy Loams	1.5	2.0
Sand	1.0	4.0
USGA Golf Green	3.0	4.0-8.0

soil or in cases where the gravel layer was not included at all. The thin layer of sand just cannot compete with the subsoil for water. The water moves from the larger pores in the sand to smaller pores in the subsoil. This results in the rapid drying of golf green after each irrigation. The best solution to the dry zone around the edge of the greens is to install a waterproof plastic barrier between the top mixture and the underlying soil around the edges when the green is built (see Fig. 2). This will prevent the water from moving to the subsoil. If you have greens that are droughty, the only choice is to water very frequently and inefficiently, or to rebuild the greens. Construction details are available from the U.S.G.A Greens Section.

Many properly constructed golf greens have been ruined by topdressing with impermeable mixtures. If topdressing is needed, the original green mixture should be used.

SPRINKLER UNIFORMITY

Increased attention will need to be given to sprinkler uniformity. Many of the sprinklers I have tested put out twice as much water in some areas as they do in others. Thus to get enough water on one part of the golf course, it may be necessary to put twice as much on other areas. Often the sprinkler heads presently available are adequate if proper spacing and configurations are used. Improvements can be made by putting the sprinkler heads on triangular patterns rather than in the rectangular pattern often recommended by the manufacturer. This may require more sprinkler heads but will save water. It is a simple matter to test irrigation uniformity. Only a set of tin cans and ruler to measure the depth of the collected water are needed.

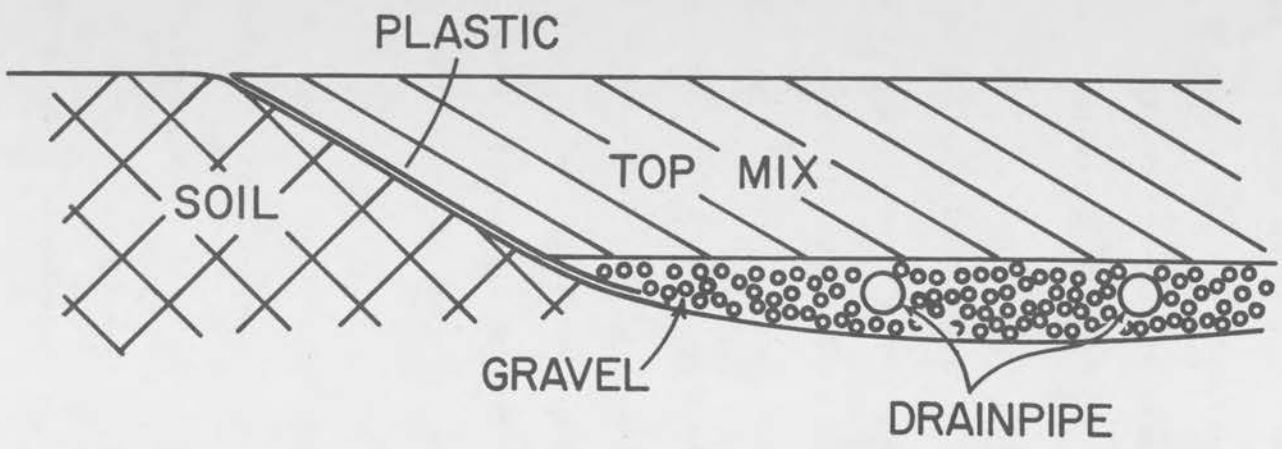


Figure 2. Schematic diagram indicating the position of a plastic barrier to prevent the movement of water from the top mixture to the base soil around the adeges of the golf green.

One of the keys to proper irrigation management is to know how much your are putting on.

HOW MUCH WATER TO APPLY

Application rate should never exceed the infiltration rate. Once this has been achieved, the goal should be to apply just enough irrigation to supplement the natural rainfall, except in those few cases where periodic leaching is desirable. The present practice is often to irrigate on a set schedule irrespective of rain. This is obviously wasteful. A simple mercury switch to turn off the automatic irrigation once a certain amount of rain has fallen may be all that is needed. Such a switch is shown in Figure 3. When planning the irrigation needs for a golf course, they must be figured month by month for each location. Annual rates of evapotranspiration in Texas are shown in Figure 4. The annual water deficient is shown in Figure 5. This might be interpreted to mean that no irrigation is needed in the eastern one fifth of the state. Unfortunately, the rainfall never occurs uniformly enough so that irrigation can be eliminated.

Assuming no rainfall and clear hot days, a maximum of 3/8 inches per day can be lost to evapotranspiration. Thus if your water storage is 2 inches, you can apply up to a 5-day supply at one time if the soil is dry when you start irrigating. Smaller more frequent applications every day are hwoever more desirable provided they are scheduled to keep the soil moist but not continuously wet. With frequent light applications, the soil will have the capacity to absorb and store the occasional rainfall which might otherwise be lost as runoff if it occurred just after a heavy irrigation.

The innovation of buried trickle irrigation provides the ultimate

Figure 3. When a predetermined amount of rain is collected in the can, the balance tips and the measuring switch cut off the electricity to the automatic irrigation system.

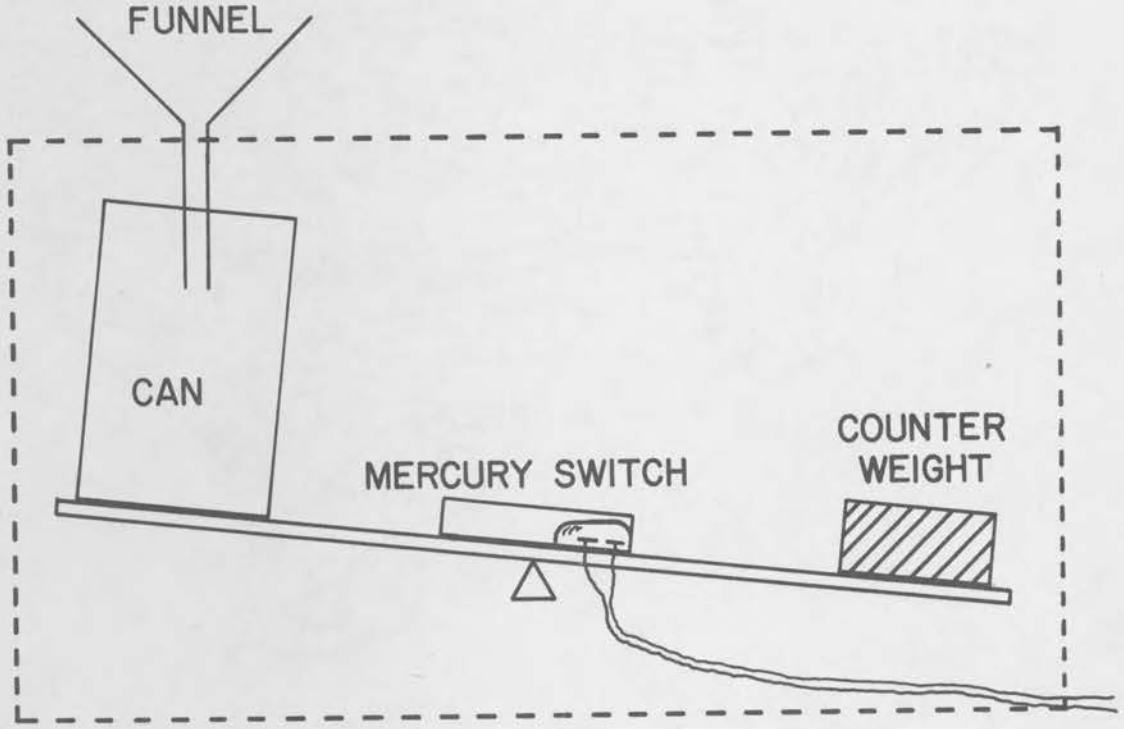


Figure 4. Average annual potential evapotranspiration in inches of water computed by the Thornthwaite equation.

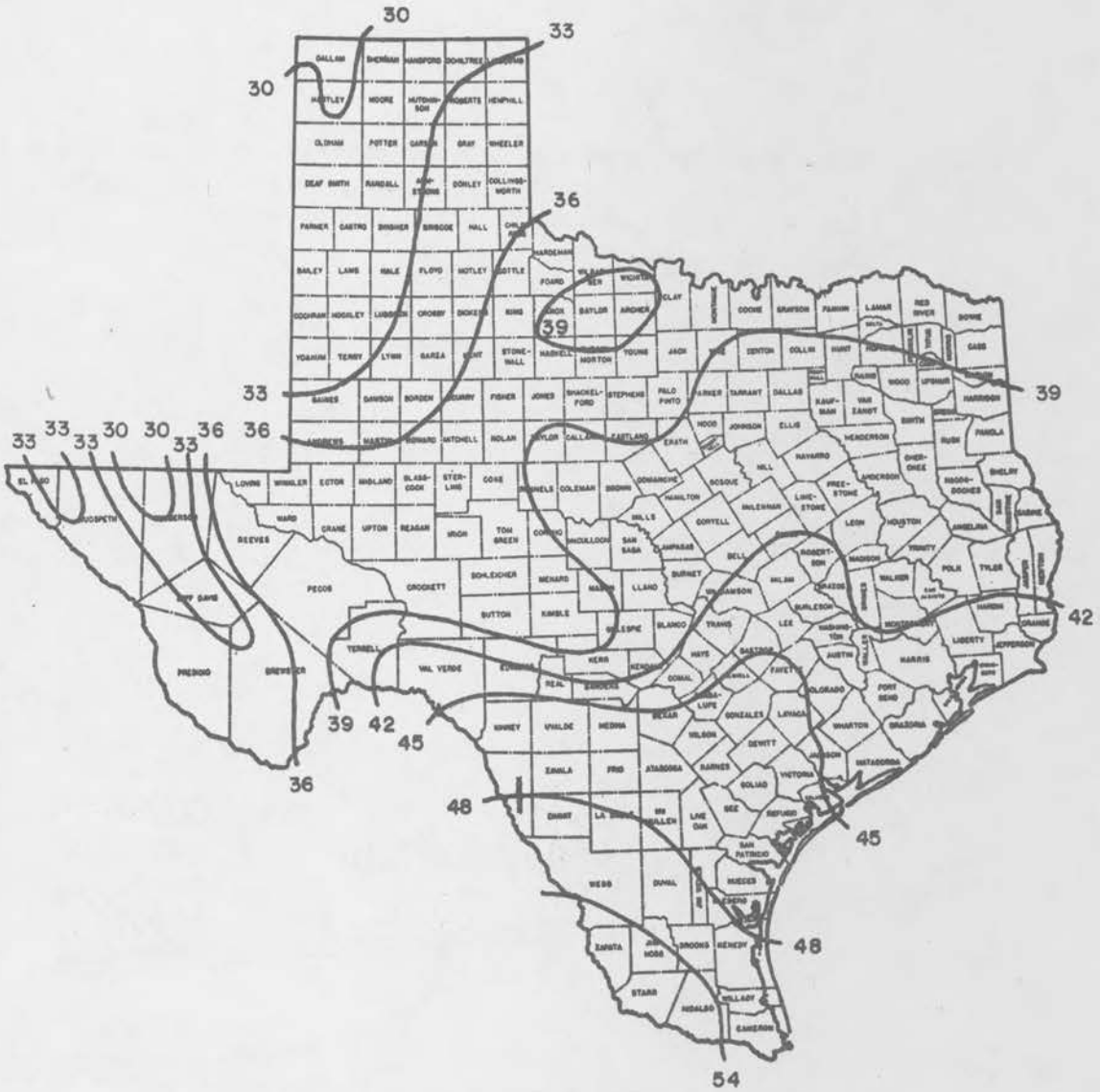
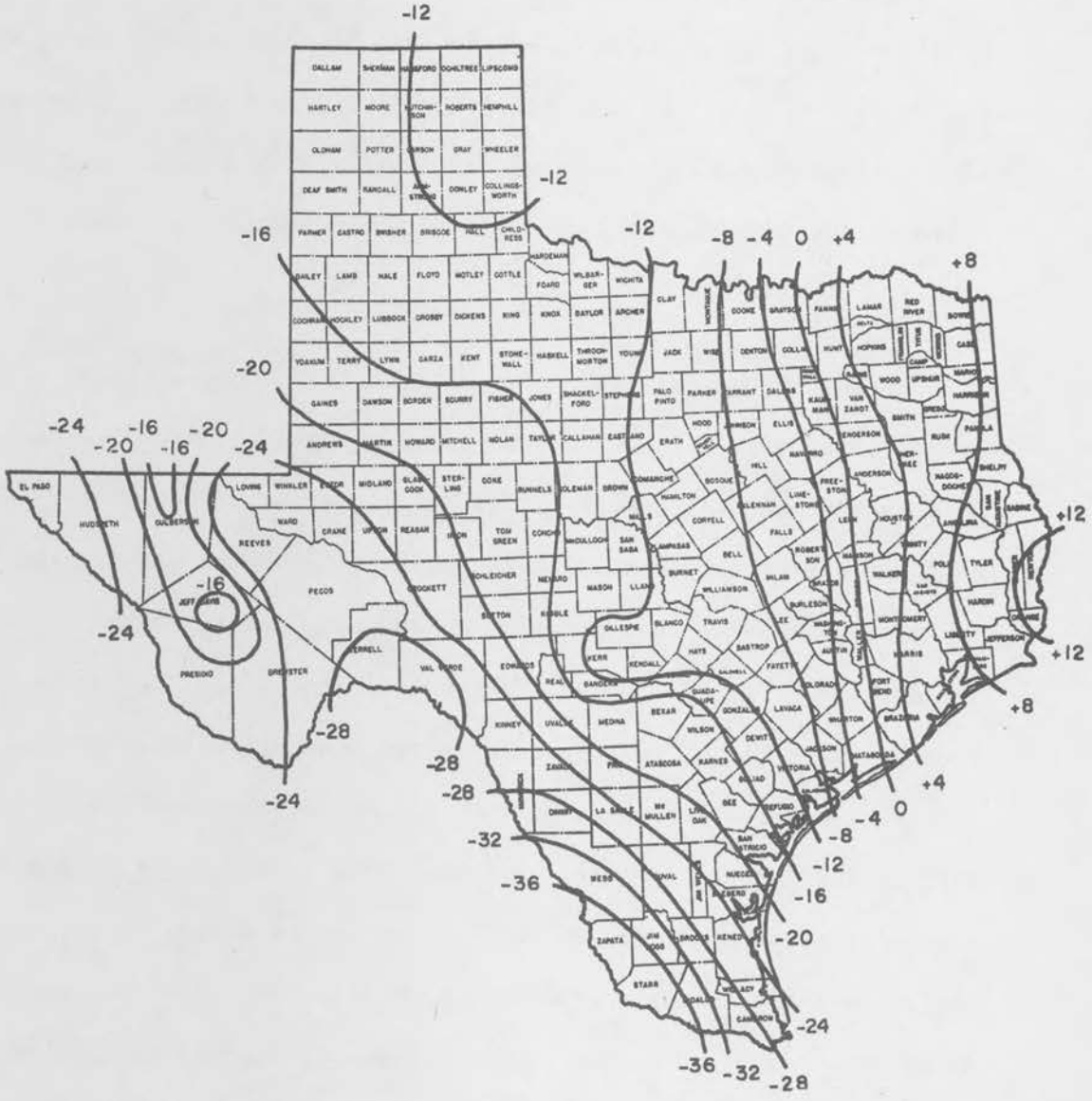


Figure 5. The difference between average annual rainfall and average annual potential evapotranspiration. Negative values indicate a deficit of water. Values are given in inches.



in slow, nearly continuous application, provided the salts can be washed out. It appears that grass roots will grow quite some distance to get water and the irrigation tubes can be spaced at 3 to 4 feet intervals at 6 to 8 inches under the surface. While the expense is quite high and problems exist with rodents chewing the pipes and orifices plugging, trickle irrigation may be able to save up to half the water that would be used by sprinkler systems. The influence of salt accumulation between trickle irrigation systems has not been thoroughly studied and may present salt problems in some areas.

WHEN TO WATER

Certainly the easy way is to wait until the grass wilts. This, however, is poor since the grass growth slows down before wilting is observed and will result in loss of vigor and ground cover. While many devices have been sold in the past to determine how dry the soil is, the only device that provides an accurate answer is the tensiometer. The details of a tensiometer are shown in Figure 6. The hollow tube must be kept full of water and recharged when air bubbles develop. Once the tensiometer is charged, as the soil dries, the water is sucked through the porous cup into the soil. This results in a vacuum inside the tensiometer which can be read on the vacuum gauge. The vacuum gauges normally used are graduated from 0 to 100. For a tensiometer placed six inches under the grass surface, irrigation of most soils should begin when the reading reaches 50. Irrigation of a green with a high percentage of sand should begin when the reading reaches 35. Tensiometers come in many designs including some that can be placed in boxes under the surface and some that can be carried from place to place and pushed into the soil when one wants to take a reading.

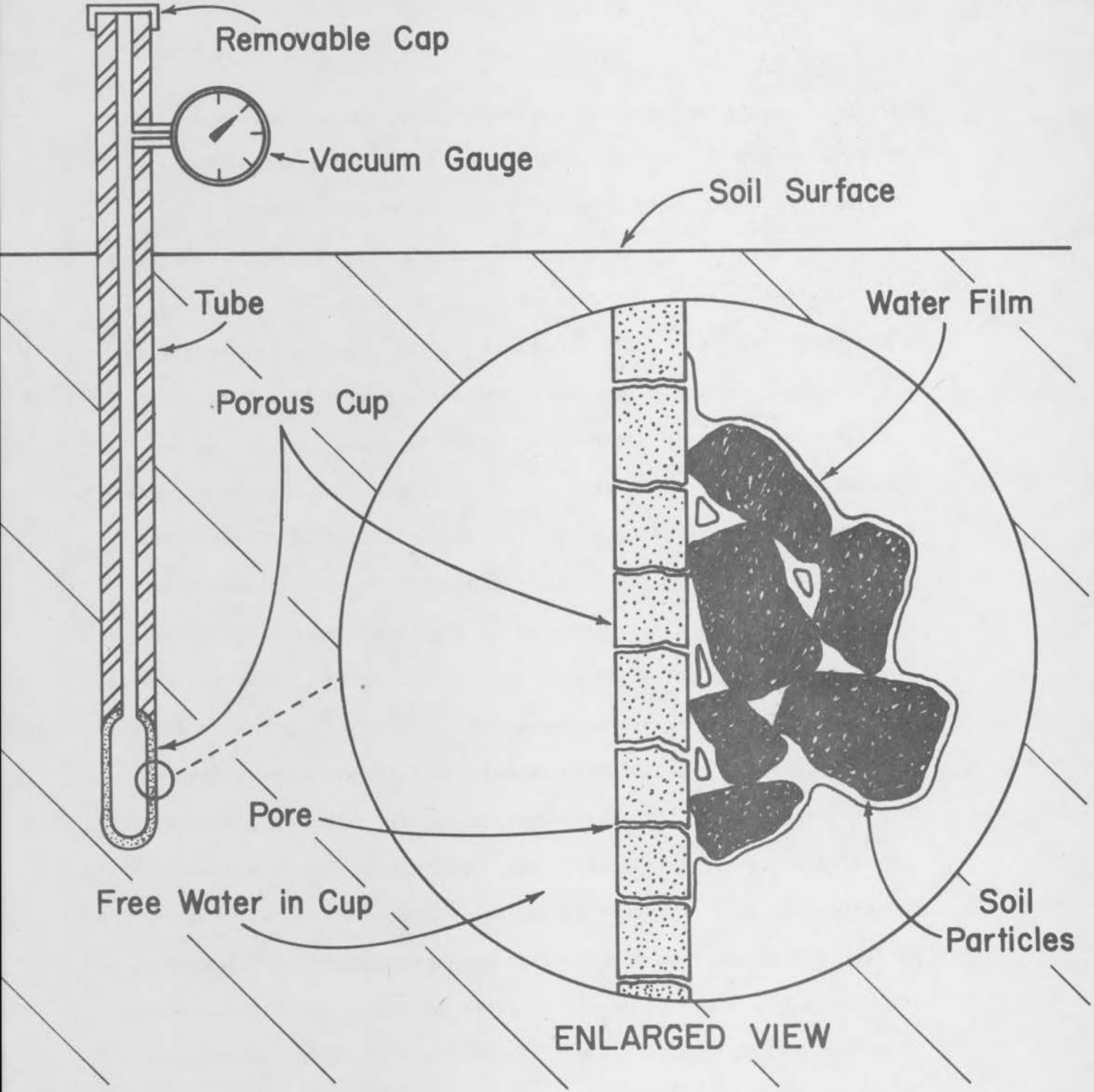


Figure 6. Tensiometer used to measure the soil moisture suction.

IRRIGATION WITH SEWAGE EFFLUENT

Several golf courses are presently being irrigated with sewage effluent and as the need to conserve and reuse water increases, the practice may become more common. There are several factors that must be considered. First, only secondary or better quality effluent that has been properly chlorinated should be used. Raw sewage or primary effluent must not be used. While the organisms in such water are destroyed rapidly in the soil, precautions must be taken, particularly with automatic systems, to insure that the effluent is not sprayed on golfers. They tend to get upset about it. While it would be nice to have a valve that would allow one to use either city water or the effluent, in the case that the sewage plants break down, such an arrangement is not acceptable since the chance exists that some of the effluent could get mixed with the drinking water. However, sewage plants do occasionally break down and the effluent is not pure enough to irrigate with. Special arrangements including a one way trap must thus be available to introduce other water into your irrigation system.

In some cases, golf courses have been viewed as a place where the effluent can be disposed of and one is asked to use as much as possible. Care must be exercised in such cases since the flow from the sewage plants may be nearly constant all year, but the evapotranspiration rate may be very low in January and Febuary. Storage ponds are often not acceptable because of odor problems. Thus, if you are to dispose of a certain amount of effluent year round, the only solution is to have sufficient land available so that all the water can be put on the land year round. The system should be designed such that all the golf course can be irrigated during high evapotranspiration periods. During other times adjacent land including woods and

parks should be irrigated when the need to get rid of the water occurs. How much water can be utilized depends on the infiltration rate and the water conducting characteristics of the soil. If a high water table is not a problem, two to three times the evapotranspiration rate can be disposed of if the soil is permeable enough. The high rates will result in considerable ground water rechange.

The amount of salts in sewage effluent does not differ greatly from that in tap water, and precautions for salt are no different for sewage effluent than for any other sources of water. The sewage plant lab will be able to tell you how much salt is in the effluent. The concentration of heavy metals and other constituents that may be toxic to grass are very low in properly treated effluents and should present no problems on the golf course. The nutrient level of effluent is low and often unreliable. While some phosphorous may be present, the unpredictable changes in soap constituents used in the home can cause large fluctuations in phosphorous concentrations. If you want to take advantage of the nutrients in the water, analysis will be needed periodically. Otherwise the effluent should be considered to be just water.

FERTILIZER REQUIREMENTS

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During the past few weeks you've perhaps read or at least heard that legislation was being introduced in the United States Congress that would affect the production and availability of fertilizer of turf use.

A bill dealing with this subject has been introduced by Senator Clark. I would like to quote Senator Clark from the Congressional Record of November 19, 1974.

> Mr. President, the World Food Conference has focused increased international attention on world hunger and starvation. The problem is a terribly real one and much can and should be done by the world's more affluent nations to help remedy it.
>
> Today, I am introducing legislation which represents only one of the many steps necessary to reduce and eventually eliminate starvation and malnutrition throughout the world. The purpose of the bill is to increase world food production by increasing the availability of fertilizer for agriculture...
>
> One way to help alleviate this is to encourage the use of as much of the world's fertilizer as possible for agricultural production. This, in turn, means using as little as possible for ornamental and decorative growing purposes. It has been estimated that as much as 15 percent of the fertilizer used in the United States is for nonfarm purposes, the great bulk of this for ornamental use. This is approximately 4 percent of the world's fertilizer use--as much as the entire nation of India uses, and more than any other of the

less developed countries uses. If a substantial portion of this fertilizer could be diverted to agriculture it could result in a significant increase in world food production in the coming year...

Now I would like to read Senate Bill #4165.

A bill to make more chemical fertilizer available throughout the world for the production of food during 1975 by substantially reducing the amount of such fertilizer used in the United States for nonfood-growing purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

That the Congress finds that--

(1) Shortfalls in food production over the past several years have resulted in malnutrition, suffering and starvation for millions of people throughout the world.

(2) A significant factor in these shortfalls in food production has been the lack of availability of fertilizer supplies.

(3) Considerable potential exists for increasing fertilizer availability through conservation measures such as reducing nonfood producing uses of fertilizer supplies which would be directed into food production and more efficient application of fertilizer supplies available for food production.

Sec.2 In order to address the crucial shortfall of fertilizer for food production the President shall appoint a Commission on Fertilizer Availability (1) to review and recommend specific conservation steps and other measures which would be taken to increase the short-term availability of fertilizer for food production and (2) to encourage

increased production of fertilizer to meet the medium and long-term fertilizer needs such as investment incentives, priority access to basic materials and machinery to increase production capacity, and necessary adjustments in the cost structure of fertilizer feed stocks.

Sec. 3 No department or agency of the Federal Government, including the United States Postal Service and Federal corporations, shall use chemical fertilizer during the calendar year 1975 for ornamental or decorative growing purposes in any amount greater than an amount equal to 10 percentum of the average annual amount of such fertilizer used by such departments and agencies for such purposes during the calendar years 1972, 1973, and 1974. The foregoing limitation shall not apply with respect to any ornamental or decorative growing purpose the primary purpose of which is to prevent soil erosion or serve some other necessary conservation purpose.

Sec. 4 It is the sense of the Congress that the President shall issue a proclamation calling upon all States, and political subdivisions thereof, and upon all corporations, associations, foundations, and other entities, and on all private individuals of the United States to substantially reduce the amount of chemical fertilizer they purchase and use for ornamental or decorative growing purposes which could be redirected into food production during the calendar year 1975.

While this bill has no real effect on our turf production, I think it bears watching. If it makes it out of Committee it is always subject to amendment. Needless to say, we all are interested in the outcome.

During the past year or so we've seen the price of some fertilizers more than double. There is little indication that this trend will end; in fact,

if turf fertilizer production is reduced, prices might climb at even a higher rate. There are several ways to react to higher fertilizer prices. One, of course, is to pay whatever the price is. Many clubs could afford a higher fertilizer budget, but many cannot. Clubs that cannot increase their fertilizer budgets have the choice of reducing the rate of fertilizer application to parts of the course such as fairways, or completely eliminating the fertilization of parts of the course.

Which alternative is easiest or best for a club? You, as a golf course superintendent, and your club will have to decide. Your job is to present the facts so that when a decision is made all concerned will understand the consequences of the decision.

First, in considering any decision regarding fertilizer usage, I think we should understand why fertilizer is considered a necessity and why some areas, such as greens, require higher fertilizer application rates. I feel one of the basic reasons for the fertilization of turf is the prevention of damage from traffic. The more trafficked a turf area, either by people or equipment, the more resulting wear. Traffic is one of our greatest problems.

We already do a great deal to combat damage from traffic. We move the flag around the green every so often. We have cart paths to reduce fairway wear. Tee markers are moved periodically to prevent wear. While procedures such as these do a great deal to prevent excessive wear by spreading out traffic, a point may be reached where the turf can no longer support any traffic and the turf thins out.

Fertilizer is a growth regulator and can help produce a growth rate that can go a long way in preventing injury from traffic. All turf surfaces, in a sense, wear out--plants die from natural causes,

disease, mechanical injury, etc. We seldom see this because most turf is growing fast enough to replace the dead plants almost automatically. When growth rates are reduced, replacement of dead plants does not occur at a fast enough rate and voids begin to appear in the turf. We, then, want a balance between the rate of wear (traffic) and the growth rate of the turf plant. This means, as far as fertilizer is concerned, the higher the traffic load, the higher the fertilizer rates.

I am sure that most fertilize at higher rates than absolutely necessary. Many times I've seen a good dense green that isn't showing any wear, but additional fertilizers are used primarily to improve color. Is that dark green color necessary when the turf is serving its prime function of adequately supporting play?

I sense that most turf breeding programs have used a dark green color as a prime selection factor. Of course it takes fertilizer to produce that color. I have never seen a breeding program that looked for superior growth response at low fertility levels. If such a program were developed it well could be that the grasses the breeders selected as superior at low fertility levels would be several shades lighter than those you are use to. You would have to support the concept of lighter grasses, and so would the public.

A turf breeding program is a very sound approach, but it takes time to develop a new grass variety. The fertilizer problem is at hand.

There are several maintenance points to consider. None of these alone will dramatically reduce your fertilizer needs, but taken all in all they might help.

Basic to any nutrition program should be a constant monitoring

of soil pH. The pH of the soil affects the availability of nutrients in the soil. Soils with high or low pH's have restricted nutrient supplies. Most plant nutritionists agree that a pH from 6.0 to 6.5 is optimum. The point is that if your soil pH is not in that range you may not be getting an optimum release of nutrients from the soil and this could force higher fertilizer rates.

Height-of-cut has a great deal to do with growth rates and thus fertilizer needs. A plant that is allowed to mature has a lower nutrient requirement than one that is constantly kept in a vegetative stage by low mowing. While, of course, there may be areas that are not amendable to a higher height-of-cut such as greens, it may be possible to raise the height-of-cut of roughs and fairways.

Over irrigation and the resulting loss of nutrients by leaching is another factor which might contribute to higher fertilizer usage. The movement of nutrients either from exchange sites on clay minerals or from a fertilizer carrier to a plant is dependent on the presence of soil water. If soil water levels rise above field capacity, as they would when turf is over irrigated, a downward movement of water containing nutrients occurs. Once the nutrients move out of the root zone they are lost.

The use of growth retardants may also play a part in fertilizer economy. As indicated before, as growth rates are reduced, so may be fertilizer rates. When considering any areas for growth retardant application remember that slow growing turf will not take traffic well.

Soluble nitrogen fertilizers are more easily leached than slowly soluble nitrogen fertilizers. This means that fertilizers with a higher

percentage of water insoluble nitrogen (W.I.N.) will not only feed turf over a longer period, but a lower percentage of their nitrogen will be lost by leaching.

As I am sure you know, there are many uncontrollable factors, such as the environment, that have an effect on fertilizer utilization. A lot of good specific fertilizer information is available from your local Cooperative Extension Service or your state College of Agriculture such as Texas A&M.

What, then, is a minimum fertilizer requirement for turfgrass? To be honest, that's hard to say. It all depends on what you can do. I would suggest that you consider a slow reduction of your application rates. Perhaps as little as 1/8 lb./N/1,000 sq. ft./month to start. Then if turf doesn't show any evidence of wear, consider another reduction.

My point is that if you really want to reduce your fertilizer usage you will need to experiment. Cut back slowly but watch for signs of wear. The growth rates must stay high enough to keep ahead of traffic damage.

We certainly don't know what will affect our industry in the future, but it is fairly evident that the government may have even more to say about how we do things or what we do them with. With increased costs in all areas each year we should seriously consider ways to reduce spending. Fertilizer perhaps can be one area.

TURFGRASS VARIETIES AND USES

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Turfgrass varieties selected on the basis of: (1) adaptation to the climatic parameters of a region, (2) the uses that the variety will be subjected to, and (3) the agronomic characteristics of available varieties, should provide sound guidelines in having the most suitable turfgrasses for the beautification of golf courses, parks and other institutional categories.

In Texas, we have a somewhat unique situation in that climatic variation will allow the use of both major categories of grasses - the warm climate and cool climate groups. Further, a wide range of rainfall patterns seasonally require that selection of varieties take into consideration the specific agronomic factors of drought tolerance in some turf use sites.

To provide some perspective on variety selection for various turf use situations, let's take a few minutes to examine in more detail how each force influences our decision.

Climate and Variety Selection

The influence of climate on selection of varieties for different turf applications is a critical criteria for consideration. Temperature is the key factor of climate that dictates selection where irrigation is not limiting.

Genetically, varieties within species differ relative to tolerating temperature extremes. St. Augustinegrass, the common name designation for

the grasses falling in the species Stenotaphrum secundatum, is much less cold tolerant than bermudagrass of the species Cynodon. If one observes side by side as freezing temperatures occur, both will show a similar reaction - leaves and stems take on a straw color. Where freezing temperatures are moderate through the winter and then followed by the normal late winter spring temperatures, both species break winter dormancy at about the same time. This would occur with consistency in the Houston area. If one moves to the west Texas or north Texas area the behavior of the two species differs, particularly in the shift from winter dormancy to active growth. St. Augustine often will be killed or severely damage and may exhibit a spotty growth recovery in turfed areas while bermuda generally will make the transition quite uniformly. St. Augustine will survive better in protected areas under trees and around buildings and where thatch is not heavy. The basic difference in this response is genetically controlled. Bermudagrass appears to have the genetic capacity to go through a hardening-off process to avoid damage from freezing temperatures. Secondly, it has rhizomes possessing growing points that are within the soil which further provide some protection from freezing temperatures. St. Augustine apparently lacks the genetic capacity to go through the hardening-off process. In addition it does not have a rhizome system that would provide another escaping mechanism.

St. Augustine is well adapted to the east, central and South Texas areas, but would be classified as a substantial risk to use in west, and north (beyond Dallas and Ft. Worth) Texas. Bermuda may be used in all areas of the state.

When one considers grass varieties from the cool-climate group such as bluegrass, fine and coarse fescue, and ryegrass for use in Texas, the

temperature factor again comes into play. While the grasses from this group may be used in the panhandle area of Texas, they would not be adapted for year round use in most other areas of Texas.

The cool-climate grasses do not have the genetic capacity to persist under the high summer temperatures. Inadequacy of these grasses to adapt physiological functions where a suitable carbohydrate reserve is maintained appears to be a key limiting factor.

The bentgrasses hold a unique position relative to their use on greens in areas of Texas where cool-climate grasses in general are not adapted. Intense management programs on greens tends to override the adverse temperature effect. Through the careful use of water (syringing greens during the day) at times when temperatures are excessive modifies the physiological processes to where several varieties within the Agrostis species may be used year round over much of Texas with reasonably good success.

Texas represents a rather unique state in that climatic conditions vary so widely that both cool-climate and warm-climate grasses may be used very successfully in given regions.

Grass Selection Based On Use

After satisfying the climatic requirements relative to selecting broad groups of grasses that will survive, the next area that must be assessed is what the grass is intended to be used for. A number of related use factors must be considered by the turf manager in making the optimum selection of grasses. Some use-related factors considered important are:

- Site
- Season of Use

Site: Site is considered here to refer to use locations of shade vs no-shade; greens vs fairways; parks; cemeteries; road slopes; turfed areas that may

or may not be irrigated; school and industrial turf areas, etc. The site in this context generally dictates the choice of species or varieties.

The currently available fine leaved hybrid bermudagrasses would be poor choices for use for general wide use in park areas where high maintenance cannot be provided. In contrast common bermudagrass will provide a very acceptable turf under relatively low maintenance yet will respond to produce a superior turf at higher maintenance levels in most areas of Texas. The same factors of maintenance should be considered in selecting a variety for fairway sites. We often see cases where superintendents select the fine leaved bermudagrass hybrids for use on fairways. This would be a good choice if the superintendent has the capabilities to maintain these grasses; however, if one has a limited budget for maintenance labor, fertilizers, and equipment, then some definite problems may be experienced. A general grouping of grasses relative to maintenance to provide a satisfactory turf are as follows:

High maintenance - fine leaved hybrid bermudagrass varieties, bentgrass (greens use).

Moderate maintenance - St. Augustine, Zoysia, Kentucky bluegrass (where adapted).

Low maintenance - common bermudagrass, centipede, carpetgrass.

Sites where heavy shade is present, the choice would be St. Augustine grass. This assumes that you are in an area of Texas where St. Agugustine is adapted. Further, if the shade site is a golf fairway then St. Augustine would not be a good choice as it does not withstand traffic well and is not adapted to low mowing heights as required on fairways. The alternate choice

here would be to go to a bermudagrass variety but some steps would be required to maintain the bermudagrass. In this case selective pruning of trees or some tree removal may be required to hold satisfactory turf.

The grasses adapted to in Texas that may be grouped into categories for shade tolerance are as follows:

Tolerate little shade - bermudagrass, carpetgrass, Kentucky bluegrass (where adapted).

Tolerate partial shade - zoysia, centipede, fine fescues (where adapted)

Tolerate heavy shade - St. Augustine grass

Another use related factor that the turf manager should consider in selecting grasses in relation to site is the degree of traffic that turf will be subject to. While St. Augustine grass and carpetgrass are sensitive to traffic, bermudagrass and zoysiagrass will tolerate higher traffic levels. The bentgrasses used on greens in some areas of Texas tolerate traffic quite well, although they will thin during hot weather as they do not have the capacity to recover from traffic injury during such periods as the bermudagrasses. The Kentucky bluegrasses when used in the Panhandle area of Texas are moderately tolerant to traffic, but will require a slightly different maintenance program than bermudagrass under such conditions. Grouping of grasses in general categories relative to tolerance to traffic are as follows:

Tolerate light traffic - St. Augustine grass, centipedegrass, carpetgrass

Tolerate moderate traffic - Kentucky bluegrass, bentgrasses (where adapted)

Tolerate heavy traffic - common bermudagrass, fine leaved hybrid bermudagrasses, zoysiagrass

On sites where soil salinity is a problem it is again important to take inventory of the grasses relative to their salinity tolerance level. Grasses that are available to select from in Texas and their grouping relative to salintiy tolerance are as follows:

Good tolerance - bermudagrass, zoysiagrass, St. Augustine grass, Seaside bentgrass

Medium tolerance - Cohansey bentgrass

Poor tolerance - Kentucky bluegrass, centipedegrass, Penncross bentgrass

Season of Use: Within the past decade, the practice of over-seeding greens and tees to provide year round activity growing turf has increase steadily. In this use situation it is necessary to use both the cool-climate and warm-climate grasses. The selection of varieties and species from the cool-climate grass category should take into account texture, rate of establishment, disease tolerance and spring transition where these are used to provide winter growth and color.

Initially annual ryegrass was used, but rate of growth, coarser texture, general susceptability to diseases and an undesirable spring transiton have discouraged its use in recent years.

Grasses from the cool-climate group that appear to provide the most suitable selection for winter overseeding include:

*Improved perennial ryegrasses

*Seeded creeping bentgrasses

*Improved fine fescues

*Poa trivialis

*Improved Kentucky bluegrasses

Characteristics of Varieties

Varieties of St. Augustine grass that are used in Texas and the general characteristics of these varieties are as follows:

*Common St. Augustine grass: Is considered the most widely adapted variety for the state. It has good relative cold tolerance, a pleasing color, vigorous, and provides a superior turf provided satisfactory maintenance practices are used. This variety is susceptible to brown patch disease, St. Augustine Decline Virus (SAD) and chinchbug. Suitable fungicides and insecticides are available to control brown patch disease and chinchbugs, however, no products are available to control the SAD. This disease may be masked quite effectively by timely applications of iron and a balanced fertilization program.

*Floratam St. Augustine grass: This variety, recently released jointly by Texas A&M and the University of Florida, shows good resistance to the SAD disease and has been reported to exhibit tolerance to chinchbug. It appears to produce a coarser textured turf than Common St. Augustine and more upright growth. Preliminary test results suggest it to be less cold tolerant than Common St. Augustine grass.

In the bermudagrass group, a number of varieties are well adapted for use in Texas. Characteristics of the more important varieties are listed

as follows:

*Common bermudagrass: Is available to plant either by seed or vegetatively. In general, this variety is very durable and widely adapted throughout the state. It produces a medium textured turf, is vigorous and has a pleasing color. Ideal choice for use in areas where traffic is expected. It performs well under both low and high maintenance. Finds wide use in parks, school grounds, road slopes, golf fairways, and cemeteries.

*Texturf 10 bermudagrass: An improved variety released by Texas A&M University. It produces a compact turf, has medium leaf texture, withstands traffic well, is vigorous and has a pleasing dark green color. This variety is considered as one of the best choices for athletic fields.

*Tifgreen bermudagrass: This is still considered the so called "workhorse" of varieties used for golf greens in Texas. The high vigor and tolerance to traffic plus its wide adaptation throughout the state supports its choice as a key variety for greens use. It is fine textured, has a pleasing color, and has a relatively good tolerance level to common diseases. The variety will thatch quite heavily if not properly maintained. This factor posed considerable problem to many of you when it was first used here in Texas. Now that you have learned to manage it, the thatch problem is not quite so challenging.

*Tifdwarf bermudagrass: This represents the other more popular fine leaved variety used on golf greens in Texas. This variety is characterized by a low compact growth profile, produces a fine dense putting

surface and has a good tolerance level to traffic. It appears to be well adapted throughout most of Texas. Thatch buildup can be just as severe as for Tifgreen if not porperly maintained. A problem that has bothered a number of you, relates to the textural / color variation noted on greens planted to Tifdwarf after several years. It is not known to-date whether this variation is due to physical contamination or a sector mutation phenomena.

*Tifway bermudagrass: Of the improved fine leaved varieties, Tifway is most often selected for use on golf tees and fairways. For the golf course where capabilites exist for maintaining this variety, it provides an excellent choice. It will thatch up quite heavily if mowing maintenance is not monitored closely, thus, it may not be an ideal choice for the low budget golf course, parks, school grounds or cemetery areas. Tifway produces a tight, stiff turf that holds a golf ball well on fairways and tees. It has relatively good tolerance to common diseases, is vigorous and withstands traffic well.

*Zoysiagrass: Meyer and Emerald varieties of zoysiagrass have been used sporadically for numerous turf applications in Texas. These varieties will produce an excellent turf, withstand traffic quite well and have a relatively fine leaf texture. The varieties are established vegetatively and cover very slowly if sprigged or plugged into turf areas. This is one of the key limiting factors contributing to their limited use. After establishment, thatch buildup can be a problem. The varieties have about the same cold tolerance level as the bermudagrasses.

*Centipedegrass: A slow growing low maintenance grass that finds very

limited use in Texas. Lacks cold tolerance, thus its use is most successful along the Gulf Coast. This variety may be established from seed.

*Carpetgrass: This grass is somewhat similar to St. Augustine grass in appearance. It is used to a limited extent in Texas. Considered to lack a level of cold tolerance to be used widely over Texas. May be established by seed and vegetatively.

*Bentgrasses: Penncross and Cohansey varieties of creeping bentgrass are the more popular choices for golf greens use in Texas where adapted. Penncross is a seeded variety while Cohansey must be vegetatively planted. The varieties produce an excellent putting surface when properly maintained. Both will tend to weaken when summer temperatures become excessive and persist for long periods. Seaside has been used over the years, but generally is not as well adapted as Penncross and Cohansey. It does appear to have a high tolerance level to saline soils and may offer potential in such a use situation.

*Kentucky bluegrass: A number of improved varieties have been developed and commercialized in recent years. Some appear to perform quite well in the panhandle area of Texas for permanent turf applications. In addition some varieties are quite well adapted in winter overseeding mixtures.

*Perennial ryegrasses: Pennfine, Manhattan and several other improved varieties in recent years have been found to perform very well in the winter overseeding use application. Their fine texture, good vigor,

relatively good transition and good disease tolerance make them popular choices.

*Fine fescues: Find widest use as a component in winter overseeding mixtures. Improved varieties such as Jamestown and Highlight show good promise for the overseeding application.

*Miscellaneous grasses: Poa trivialis is used quite extensively in winter overseeding mixtures. Its adaptation to wet cool conditions, fine leaf texture, its good vigor and fine putting qualities represent some plus characteristics. A major problem that has been experienced with the variety relates to its physical seed purity. It is quite difficult to find seed free of undesirable weeds and problem grasses.

MAINTAINING A PURE STAND OF GRASS

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It is hard to maintain a pure stand of bermudagrass. There is considerable mixing of bermudagrasses especially in the greens. We see some mixtures in fairways, tees, and roughs but turfgrass areas are of less concern.

Maintaining a pure stand of bermudagrass is the responsibility of the researcher, the sod grower, and the turfgrass manager. The researcher has a long, tedious job in selecting the strains of turfgrass. He has to keep close surveillance while evaluating the merits he wants. There is constant roguing of foreign bermudagrasses from research plots. Before releasing any strains of grass, there have been several years of testing pure strains.

It is difficult for the researcher to keep the very small plots from being mixed and constant surveillance is necessary to maintain plots free of weeds and grasses growing across alleyways.

Bermudagrass is heterogenous indicating an unstable tendency since we see so much variation. We also observe variation of strains in greens where the grass is under stress. Many of the common bermudagrass selections have viable seeds sometime during the year which makes it easy for the golfer to transport seed into the greens. The hybrids have sterile seed and should have no mixing from seed produced from Tifway, Tifgreen, Tifdwarf, and others.

There are so many ways common bermudagrass seed can be moved into the greens that it is quite difficult to keep a pure stand. A strong healthy

turf in the greens is the best defense.

It is much easier to observe a mixture of grasses in small research plots and greens than it is in fairways, athletic fields, and other large turfgrass areas. The spectators at sport events are not really concerned about the mixture of grasses as the turfgrass manager is in his green. The best putting surfaces have pure strains of grasses or grasses that have very similar texture expecially with hybrid bermuda-grasses.

In recent years, we have observed different strains of grasses in areas of hybrids where the grass is under stress. Stress in greens can be from poor construction, partial shade, and being mowed rather close. Additional stress can be caused from chemicals, insects, and other environmental conditions. Stress from the environment has created changes in the vegetative appearance but this does not include grain. This statement is not readily accepted by many turfgrass managers but it will be very interesting in the next 5 to 10 years to see the changes that have occured in bermudagrass and what the cause may be. It is quite obvious that changes in common bermudagrass could be entirely from seed but in hybrids that have sterile seed other causes have to be considered.

When we see greens with bermudagrass in trouble and thinning out and a small spot of grass continuing to grow and spread, it is reasonable to conclude it is a different grass from some contamination or outgrowth created by the dominant grass. Selections have been made from such areas where a superior grass was taking over the established grass.

When there are mixtures of grasses in the greens, it is advisable that the mixture be removed immediately. If this is not done, the cup changer will set the undesirable bermudagrass into key pin setting areas especially

when the bermudagrass is overseeded and he cannot see where the foreign grass is located. Some cup changers do not care or do not recognize the difference in the grass.

Many small round areas in greens appear to be a different grass but are the same grass that have had the direction of the grain changed when the pin setting was moved giving an impression of a different plug of grass. Sometimes more than a year is necessary for the grass to appear the same as in adjacent areas.

In some greens where the grain is so obvious the members invariably think there are different types of grasses growing in the same green. By looking in the opposite direction, the bermudagrass grain gives a different appearance. Grain in the grass has created many serious discussions with each turfgrass manager thinking his problem is unique and many are.

One of the best methods to remove foreign grasses from the greens is to gas it with methyl bromide. Sometimes one area is gassed and resodded, plugged, or stolonized. The soil mixture should be gassed before planting to eliminate any seed or live stolons in the seedbed. It would be advisable that the area is observed immediately after the grass is beginning to grow and all foreign grass rogued as soon as there is a distinction; and if too much is present then the area should be gassed again and replanted with a pure strain of grass.

Light, chlorotic areas appearing in the greens have caused considerable concern across the South indicating a foreign grass. Many soil samples have been taken from these areas and there is a rather complex problem existing causing the grass to have a chlorotic appearance. Usually disease and nematodes cause the grass to be in a weak condition and off color.

In the middle 1960's, some chlorotic spots were treated with a nemotocide and were finally eradicated by using a fungicide over a period of two years

of repeated applications.

Soil samples from these areas were checked for nematodes, diseases, and in some cases, bermuda mites.

The diseases found were Rhizoctonia, Helminthosporium, dollarspot, Fusarium, and Pythium. Disease symptoms were noticed in samples where 50 propagules of Pythium per 1 gram of soil were present. The higher the nematode count, the more prevalent the chlorotic conditions. The nematode assay was made on 100 cc of soil.

Every 18 hole golf course should have a turfgrass nursery and it should be kept free of all foreign grasses and constant surveillance is necessary to keep a pure stand. All employees should be able to distinguish foreign grasses especially in the greens and bring it to the superintendent's attention immediately. When any foreign grass is observed, it should be removed immediately. The longer a foreign grass is allowed to remain the better established it becomes and the harder it is to eradicate.

We can summarize by stating the researcher must establish a pure stand for the certified grower and the sod nursery should pass it on to the turfgrass manager in the same condition. The turfgrass manager should keep a pure stand of grass for his members at all times. If the bermudagrasses mutate then the researcher should develop a grass that is stable and retains its characteristics to compete with foreign grasses. The turfgrass manager of the golf course should maintain a pure stand of grass by constant surveillance and from planting year after year. A pure stand of grass makes a much better putting surface and a much more attractive green.

SELECTION, PLACEMENT AND CARE OF TREES

Dr. William C. Welch
Landscape Horticulturist
Texas Agricultural Extension Service

Well placed and selected trees are of tremendous value to the homeowner and the community. During this program we will explore some of the factors that can help you make sound decisions regarding the placement of trees in your own landscape.

There are many good reasons for planting trees. The first thought that comes to mind is probably for shade. If planted where the tree will cast cooling shadows during the hot part of the year, trees can significantly reduce temperatures. This can result in lower air conditioning costs during the summer and more enjoyment from outdoor living areas. Parking areas can also be made much more attractive and inviting with properly placed trees. Few landscapes are visually successful without the added beauty of trees. Species should be selected that will provide interest for as many months during the year as possible.

Recent studies have shown that trees and shrubs can significantly reduce air and noise pollution. Evergreen trees with dense foliage such as pines, junipers and live oaks are especially appropriate for this purpose.

Many species of birds and wildlife depend upon trees for food and shelter. Their beauty and presence in nature's balance are dependent upon the trees in our environment.

If the reasons already discussed are not sufficient to send you to your local garden center in search of trees, you might consider the property value increase brought about by their presence. According to real estate professionals, well placed and selected trees are especially helpful in the sale of older homes. Consumers may prefer older neighborhoods well populated with handsome trees to new subdivisions where contractors have bulldozed the land bare.

Hopefully by now you are sold on the idea of planting some trees in your community or home landscape. The decision then is where to plant them and what species to plant. Lists of recommended trees for your area are available through your local county Extension office. Before deciding what species to plant, it is best to decide where to plant trees. Each tree or group of trees should have a practical or aesthetic reason for its placement.

Flowering trees such as the Evergreen Pear (Pyrus Kawakami) may provide the beauty of flowers in spring as well as shade during summer and leaf color in the fall. Crapemyrtle (Lagerstroemia indica) provide flowers over a long period during the summer, and attractive trunks the year round. Chinese elm (Ulmus parvifolia) is usually planted for its shade and attractive trunks while Chinese date (Zizyphus jujuba) and other fruit trees are planted primarily for their food production although many fruit trees may be worth planting for aesthetic reasons alone.

Before selecting trees to be planted close to a home or other structure one should be aware of their growth rate and ultimate size. Large trees planted too close to a home can cause serious damage and be a nuisance. It is also poor use of scale to have very large trees adjacent to small structures.

Deciduous trees lose their leaves during winter and allow the sun to reach the ground in the areas surrounding it. This can be an advantage, especially when you want a tree placed close to your home. A small deciduous tree such as a redbud, crabapple, or crapemyrtle can provide shade during the summer and allow the warm winter sun to enter the home. Deciduous trees such as this sweetgum (Liquidambar styraciflua) also provide us with fall leaf color and many of our spring flowering trees. Most well planned landscape designs include both deciduous and evergreen trees.

The reduction of heat and glare have been mentioned as a major reason for planting trees. With our long, hot summers in Texas trees become especially

important not only for our homes but also for public areas such as shopping centers, parks, and playgrounds. Trees may be planted in large containers or in cut-outs between a street and pedestrian walking areas. The monotony of large expanses of paved areas for parking can be made cooler and more attractive by including trees. If lack of space is a problem, angular parking may help. Trees can be incorporated into a parking area with a minimum sacrifice of space. Larger planting areas are more desirable but some tree species can survive under these conditions.

If you are in an area where wind is a problem consider planting a windbreak. Since winter winds are usually the problem, place a single or double row of trees where they will protect your home and garden from the prevailing winter winds. Evergreen trees such as junipers, oaks, and pines provide the best windbreaks for winter protections but usually require several years of growing before they effectively do their job.

Most people spend the largest percentage of their "at home" time inside the house. For this reason and also because many of our homes now have considerable amounts of glass in them, it is very important to create attractive views from inside the home. Trees can frame a view while providing shade. They can also provide color and fragrance with their flowers.

It is important to allow plenty of open space for lawn and recreation when planning the home landscape. If activities such as badminton, horseshoes, croquet, etc., are enjoyed by the family, trees should be placed where they will not interfere. Home vegetable gardening and most annual flowers require sun for most of the day and do not appreciate competition from nearby roots of trees.

Most attractive and satisfying landscapes have been thoroughly planned in advance. The landscape architect is the professional whose job it is to plan the home, community or business landscape. He goes through a careful process of analysis of the site, and combines this with the needs and desires of the

client to reach his design solution. Even if you are doing your own landscape design, it is important to prepare a scale drawing of the site and proposed placement of major elements such as terraces, trees, parking areas, etc. Many errors can be avoided by trying your ideas on paper first, then evaluating them for a while before installation. Trees are placed as specimens, rows, groups, or masses. Masses and groups are less formal and have a more naturalistic effect. Rows give a strong line effect and may be useful in repeating lines in the architecture of a building or home. Specimens are used for emphasis and are most effective when used sparingly.

The form of a tree is also an important consideration in its selections and placement. Some trees have a rounded spreading form such as the Chinese Pistachio (Pistacia chinensis). Others are more upright, such as the cedar elm (Ulmus crassifolia). This upright form and other desirable characteristics make the cedar elm an excellent choice for street tree use. Extremely vertical trees such as the Italian cypress have a very dominant form and should be used very carefully.

Trees may have many variations of the mentioned forms and some may be irregular such as the Texas persimmon (Diospyros texana). As you can see from these few examples, it is very important to consider form and growth habit when selecting and placing your trees.

Although good designers avoid the use of inflexible rules, the following hints may be helpful to you in selecting and placing trees:

*Avoid using too many different species. It causes a feeling of clutter or confusion. Unity can be achieved by repetition of species.

*Use native trees if possible. They generally require less maintenance and help relate your landscape to the overall environment of the area.

*Trees should be a part of the overall landscape plan.

*Small trees may outgrow larger ones. If well cared for, small trees often grow very fast, there is less shock in transplanting, and they cost less.

Also, container-grown trees usually transplant easier than bare-root or balled and burlapped specimens.

*Select only trees that are adapted to your area. Well adapted trees require far less maintenance, live longer, and usually have fewer insect or disease problems. If in doubt, check with your county Extension agent, landscape architect, nurseryman or other competent individuals.

Extension publications on the selection and care of trees that are available through your county Extension office include:

MP-1151, "Trees for Texas Landscapes"

MP-914, "Shade Tree Diseases"

B-977, "Modern Pruning Methods"

L-1097, "Fertilizing Woody Ornamentals"

L-1037, "How to Transplant Woody Plants"

L-1004, "Shade Tree Borers"

TURF ANALYSIS TEST

Dale Kern
President
Seed Technology, Inc.
Marysville, Ohio

Today there is good news for you who are professional turf men. No longer are you forced to live with the law of averages when you plant seeds. This law of averages indicates that 20 percent of the professional turf men who seed grass on golf courses will be sowing Poa annua up and down fairways next spring. That's one of every five.

Again, the law of averages says 8 percent will be planting bentgrass in fairways. Six percent will be dropping timothy seed from tee to green on No. 7 or maybe the other seventeen. Four percent will be planting sorrel -- and 5 percent will infest fairways with chickweed, come planting time in May.

These percentages are dictated by the law of averages. But, this law, like every law, has a loophole.

"Beating the law of averages" wasn't conceived by my profession. The United States Department of Agriculture thought of the idea many years ago. In fact, this department established the standards that the seed industry must meet in order to sell seed.

Standards established by the USDA were designed to protect the farmer from unscrupulous seed merchants. As you know, every lot of seed offered for sale must carry a tag or label.

The seed grower and seed merchant must be sure his seeds are properly labeled before they are offered for sale. So, the grower or merchant submits samples of seeds to laboratories for testing. These laboratories meet the specifications established by law, and provide the

seed merchant with a certificate of analysis. Now the merchant can legally label and sell his seed.

This is a good arrangement; except --- government regulations and standard laboratory tests DO NOT GIVE YOU, THE PROFESSIONAL TURFMEN, WHAT YOU NEED.

Why?

Standard laboratory tests that meet government specifications fail to tell the full story. A standard analysis tag means different things to different people. To the merchant, it means he can legally sell his wares. To the lab technician, it means all his procedures have complied with Federal Seed Act Regulations. To the buyer who will plant the seed, this tag could mean almost everything...or practically nothing.

It all depends on how much the buyer wants to know, and how much he is willing to guess.

More Info Needed

If you want beautiful fairways, with a very minimum of weed problems, then you need all the information possible. You have to know. If, on the other hand, you are satisfied with average results, you can afford to guess.

When you study the analysis tag, how much will you know, and how much will you be required to guess?

Suppose we analyze the tag. It tells, by percentage of weight, (that term is mighty important) the pure seed, crop, inert, and weeds in a sample of weed. It also tells the percentage of seeds that germinated, and date of germination test.

Now, the breakdown.

Item by item; here's what you'll know, and here's what you'll have to guess.

For example, consider a tag taken from a lot of high quality, blue tag, certified Merion bluegrass seed.

Pure Seed	97.85%
Crop	.10%
Inert	2.00%
Weeds	.05%

Again, remember, all of the figures are percentage by weight.

Let's go back to the top line...97.85%. What does this mean to you as a seed buyer? Simply this: 97.85 pounds in every 100 pound bag is pure Merion bluegrass. The other 2.15 pounds are made up of inert, crop and weeds.

If you know the percentage of pure seed, and the total number of pounds in the lot, it's a matter of multiplying the percentage by the total weight to know the pounds of pure Merion bluegrass you are getting for your dollars. There isn't much to guess about in the "Pure Seed" category.

Back to the tag---this time look at Crop percentage. Here we find the percentage figure .10%.

Now, what do you know?

Well, you know that by weight there is about one-tenth of one percent Crop Seed in the lot. You also know Crop is any seed grown for economic purpose.

Anything left to guess about? You better believe there is. First of all, what kind of crop makes up this one-tenth of one percent by weight?

If you guess Delta, Park, Newport bluegrass, or seeds of Red,

Chewings or Illahee fescue, no problem. The plants produced by these seeds will probably never be noticed by the average golfer.

But, if you guess wrong---if the crop seeds are timothy, redtop, tall fescue, ryegrass, Orchard grass or bentgrass---you're in trouble. Most of these are pasture leafed, off-color, fast growing clump or bunch grasses, and appear unsightly to everyone.

How Many Seeds

Here is something else in the Crop category you can guess---HOW MANY SEEDS are represented in this .10%.

As you know, all crop seeds are not the same size. Some are large, some are quite small. The .10% represents only about 1½ ounces in a hundred pound bag.

Suppose you are going to seed a new fairway that is about 400 yards long and 50 yards wide.

If .10% by weight of tall fescue (the seeds being quite large and heavy) this would be equivalent to 54,400 plants of this type up and down your fairway.

If this were .10% Orchard grass, it would give you 364 seeds per pound, or 72,000 seeds in your fairway of this type of plant.

Another old pasture grass often found in Merion is timothy. That .10% would produce 254,000 plants of this nature up and down your fairway.

In each case, the .10 percent of the crop seeds just mentioned would be a serious problem.

Inert Materials

Now we come to inert---the percentage by wieght of anything that is not classified as a seed. This could be corn cob, ground up hay, sand, or chaff---we've seen them all.

Here we see the figure 2.00%. The only type of inert likely to be present in the seed you are buying is chaff, which are empty hulls.

Now, let's consider the last item on our now familiar tag. Here we see weeds, .05%.

Simple arithmetic---and you will know the number of ounces or pounds of weeds in a lot of seed.

From this point on, the prognosticator can really have a field day. And, I know of no place where guessing wrong carries a greater penalty.

You can guess:

1. What kind of weeds are in the lot?
2. Are the weed seeds large or small?
3. How many seeds does this .05% represent in a 100 pound bag?
4. Are they problem weeds?
5. Will the weeds survive low, frequent mowing and a freezing winter?
6. Will the weeds spread out in all directions by underground stems called rhizomes?
7. Will the texture and color stand out and be unsightly?

If we take that .05% weeds and start seeding our 400 X 50-yard fairway, here's what could happen.

This .05% by weight of knotwood, when expanded to the fairway, would give you 75,000 of these plants to distract from the uniformity of your bluegrass. Suppose it's only .05% of chickweed. These seeds are extremely small and you could place 4 to 5 of them on the head of a pin. Their smallness would account for 560,000 of these plants up and down your fairway. Let's take a look at an old familiar one to all. If the .05% weed happened to be all Poa annua seeds that would calculate out to 151,200 annual bluegrass plants to combat. We regularly see these

weeds present in that amount. It is obvious that out in the fairway not every one of these problem seeds survive. Many do not germinate, others start to grow and are not strong enough to survive. Still others will lay in the soil for some years before they come forth to plague you. However in these great numbers, enough of them will make it to create real problems.

One Gram Tests

Now, let's consider one gram of seed. It fills a teaspoon about 2/3 full. This is the amount of seed the U.S. Department of Agriculture recommends to be used in making a purity analysis. Every laboratory in the country uses 1 gram of seed (Merion bluegrass included) to determine the percentage of pure seed, crop, inert and weeds.

This one gram is sub-divided from a large amount of seed, and could represent 5 pounds or 5,000 pounds. In spite of the very small amount of seed used, the test is fairly accurate.

When I say this one gram test is fairly accurate, I do not wish to infer that it is always adequate. This is pretty much the crux of our discussion---what is adequate for the farmer, the home gardener, or the housewife is by no stretch of imagination adequate for you as a professional turfman.

Let me explain.

Suppose we take the two items you are most interested in when you buy a lot of seed; namely, weed and crop. As I said before, every laboratory in the country uses 1 gram (or about 2/3 teaspoon of seed) in making the test. Now, if no weeds or no crop are found in this very small amount, naturally the tag would read "NONE" under the weed column, and .00% under the crop column. You, as the buyer, would assume when you read the tag

that the entire crop was free of weeds and crop.

Unfortunately, in most instances this JUST ISN'T TRUE.

If the seed laboratory were to take 10 or 25 times the original one gram and examine this amount of seed, the analyst would come up with quite a different story.

State and Federal agencies recognize the inadequacy of the one gram test. To protect the buyer, these agencies specify that 25 grams be examined for certain weed seeds.

Which Weed Seeds

The Certification agencies say the seed laboratory must look for certain weeds and list them as they examine the 25 grams. There are two that might be a problem to you; quackgrass and wild garlic. You can forget about the rest; you'll never have a serious problem with them. Keep in mind that this list was designed to cover all kinds of certified seed, not just Merion bluegrass.

What happens when the seed analyst detects other weed seeds that you and he know could be very bad in your fairway? Now remember, the government and certification instructions say to list ONLY THE WEED SEEDS SPECIFIED. Well, the analyst ingnores the other weeds--that's what he is instructed to do.

How many crop seeds will the analyst list as he examines this 25 grams? The answer is NONE.

The 25 gram examination is for certain weeds only, and that is precisely how the test is conducted. Weed seeds not on the list, and all crop seeds are ignored in the 25-gram test.

We at Seed Technology, Inc., have recognized for a long time that standard tests and simple compliance with government and certification regulations is inadequate. Professional turfmen need more information

than this from a Seed Laboratory.

When we examine the large amount for everything present, the true picture comes to light. When we examined the 25 gram for crop we found 91 bentgrass, 72 ryegrass, 18 timothy for a total of 181 per pound of obnoxious crop seed. When we examine the 25 grams for all weeds and not just the few in the states or certification list, note what happened. Instead of reporting "none found," we list 7 different kinds of weeds for a total of 797 weed seeds per pound. Included in the 797 weeds per pound are such things as 109 seeds of chickweed, and the presence of Poa annua at the rate of 91 per pound.

Poa Seldom Wanted

Poa annua is not considered prohibitive for certification and is considered noxious in only a few state seed laws. But we know what a bug-a-boo it is to most turf professionals.

Poa annua is a member of the bluegrass genera, and to the naked eye or under low magnification, it is literally impossible to distinguish it from other bluegrass. Put this same seed under a microscope and the difference is easy to spot.

Here's the problem: The total viewing area under the microscope is about the size of the head of a thumb tack. Now, how do you glue 48,000 seeds to the head of tacks, and then place all of these tacks, one by one, under the scope?

Obviously, this is impossible. At Seed Tech, we search for Poa annua under a microscope. We have combined special vibrators with a microscope, and march the seeds in a single layer under the scope. This enables our analyst to look at more seeds under higher magnification in much, much less time.

A special microscope check is made on approximately 40,000 seeds to tell you how much Poa annua is present in every pound of seed. And, we know we're right.

Another interesting operation made in every Turf Analysis test at our lab is the bentgrass check. Bentgrass is an extremely small seed, and has the tendency to lodge or stick to larger seeds and ride over the screens during the cleaning operation.

The bentgrass seed is still riding "piggyback" on the larger seed when it comes into the laboratory. This means the larger seed could, and in many instances does, hide the bentgrass from the analyst's view. You just can't turn over 120,000 seeds to see what's hiding underneath.

We solved this problem at Seed Tech by developing a special piece of equipment that literally shakes the bentgrass seed out of the larger seed. Since the bentgrass seed is smaller, it passes through special screens and is easily collected, and examined under a microscope. We are the only laboratory in the country making this kind of a check.

In the Turf Analysis test, you get the name (and number per pound) of every weed seed and every crop seed found in a 25 gram sample. This includes a special 25 gram Poa annua and bentgrass check.

New for the Industry

If you went to your family doctor for an examination along about the time the government set up the first standards for the seed industry, here is about what the good ol' doc would have done: Looked down your throat, checked your pulse and listened to your heartbeat through his stethoscope. And, that's about it.

Since that time the medical profession has developed techniques, instruments and equipment that staggers the imagination. But, the seed industry

has not made similar strides which are necessary.

What will tomorrow bring? What are we experimenting with today that will make your profession more efficient and more useful tomorrow? We can list three projects. One is available now. The other two could make exciting news--maybe next year, maybe five years from today.

In the future we see first the use of chemicals to learn if a seed is dead or alive, weak or strong. Second, the use of electronic eyes to count the seeds that germinate and measure the rate of growth. Third, micro photography will enable us to make a fingerprint of a plant or single leaf and identify it's variety or trueness to type.

The chemical triphenyl tetrazolium chloride is now being used by Seed Tech to quickly determine the germination potential of a lot of seed. At Seed Tech in 24 hours and for the cost of a carton of cigarettes you can get the known germination. This is our Tetrazolium test. The live embryo shows red, the dead seed remains white. At the present time about all we can give you in germination is the total percentage that will grow. Two lots of seed each germinating 90% can be quite different. One could be a vigorous fast growing lot and at 10 days 80 plants out of 100 would have grown to an inch height with an inch long root. In the same 10 days, the other lot might have only 30 plants of equal height and root length. With the use of electric eyes and counters we will soon be giving a germination percentage plus an A, B, or C rating depending on how many and how fast the seeds grow. This could mean cutting the critical time required to establish turf by days through choosing a fast growing lot.

The trend is for more and new varieties of grasses to become available to you. As this continues it will become increasingly important to make certain that the variety is not some old one with a new name and secondly that when you pay a premium price that you get what you're paying for.

There is good promise that by making a fingerprint of the leaf surface and then photographing it through a microscope, it will some day be possible to identify a single plant or possibly a single leaf, making certain that you are getting that highly desirable grass that you want. This service will no doubt be forthcoming in the future.

The Turf Analysis test is a break-through in giving information, and more insight into what to expect when you buy a lot of seed. But, no one recognizes more than we at Seed Tech that we must offer more comprehensive tests and analysis in the months and the years to come.

TURFGRASS RESEARCH

INTERNATIONAL TURF RESEARCH PROGRAMS

J. R. Watson
Vice-President
The Toro Company
Bloomington, Minnesota

In July, 1969 the first International Turfgrass Research Conference was held in Harrogate, England. Some fifteen nations were represented by some 85-90 people. In June, 1973, the second conference was held at Virginia Polytechnic Institute. Some seventeen to eighteen nations were represented. Attendance was well over one hundred. At both conferences United States workers attended in greater numbers, which is understandable since by far the greatest amount of turf research is conducted in the United States.

One of the major objectives of the International Research Conference was, and still is, to promote an interchange of ideas. With few exceptions most of the research conducted in foreign countries has grown out of pasture and forage programs - as it did here in early years.

Research in the Scandinavian countries has centered around development of improved grasses, primarily Kentucky Blue, and substantial quantities of this seed have been exported. This is also true of Australia and New Zealand. Commercial interests, especially in Sweden, have been the leaders in this area.

In England, the Sports Turf Research Institute at Bingley has been responsible for most of the applied research. Information as the result of this research has been disseminated throughout the British-influenced and English-speaking nations. In recent years some universities, especially in Wales have established research programs. Dr. Adams (Wales) conducted basic soil work on cricket pitches and, also, on the selection and breeding

of Kentucky Blue.

Organizations similar to the Sports Turf Institute in Holland, South Africa and Australia conduct most of the research there. In Germany, France, and to a limited extent Japan, the universities handle most of the work; in Spain, Italy, Austria, South Africa, and Japan research is conducted or supported by industry.

Research programs are for the most part of an applied nature and are concerned with current problems. Some of the programs studied and evaluated include:

1. Grass selection and evaluation including studies of mixtures - Kikuyu grasses are used worldwide, the same as our widespread use of Kukuku, except Zoysia. (2)[1]
2. Fertilizer - materials and practices (3) (12) (17) (21)
3. Topdressing - materials and techniques for applying
4. Cultivation - including hollow tine coring versus slicing and spiking (1) (8) (10) (13) (14) (15) (16) (9)
5. Pest Control
   A. Disease (11)
   B. Insects (11)
   C. Weeds (23)
6. Soil - mixtures, air-water relationships, construction techniques (4) (5)
7. Scarification - bowling greens, playing fields and golf course turf (1) (18) (22)

   Incidentally bowling greens represent a very large portion of the turf areas in the British-influenced countries.
8. Equipment evaluation, study, and to some extent, development. Toro and Jacobsen are the major suppliers of turf maintenance equipment in most of these countries. Ransome of England and Scott Bonnar of Australia and other suppliers. In short, their international turfgrass research programs are very similar to many of ours.

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[1]Refers to list of papers attached. These were presented at the Second International Turf Research Conference, 1973.

BRITAIN

1	J. P. Shildrick	The choice of cultivars for the United Kingdom
2	W. A. Adams and P. J. Bryan	Is there a future for Poa Prantensin L. as a turfgrass in Britain?
3	W. A. Adams and P. J. Bryan and G. E. Walker	An examination and interpretation of the effects of cutting height and nitrogen nutrition on the growth pattern of turfgrasses
4	G. G. Fisher	Heating turf by underground warm air
5	G. G. Fisher and A. N. Ede	Vertical band soil additive methods for established turf
6	D. J. Thornton and W. A. Adams	The use of shear strength as a measurement of traction in sportsfields
7	Ian Greenfield	Turfgrass developments in Southeast Asia

CANADA

8	D. K. Taylor	Cultivar response in turfgrass species mixture trials mowed at two heights
9	F. J. Wray	Growth curves of turfgrasses under cool wet conditions
10	T. J. Gillespie	Microclimate during wet periods on differently sheltered turfgrass swards
11	J. Drew Smith	Snow molds of turfgrasses in Saskatchewan
12	B. A. Rieger and J. L. Eggens	Tillering response of Kentucky bluegrass and annual bluegrass to TIBA (2,3,5-triiodobenzoic acid)
13	F. J. Wray	A diagrammatic aid to turfgrass management

FRANCE

14	B. Bourgoin, C. Billot and M. Kerfuelen and A. Hentgen and P. Mansas	Behavior of turfgrass species in different parts of France

GERMANY

16	P. Boeker	The root development under some turfgrass species and cultivars
17	P. Boeker and W. Opitz von Boberfeld	The influence of various fertilizers on the root development in a turfgrass mixture
18	Werner Skirde	Soil modification for sports turf areas

HOLLAND

19	R. Duyvendak and H. Vos	Registration and evaluation of turfgrasses in the Netherlands
20	J. P. Van der Horst	Turfgrass research and results of the Netherlands Sports Federation

JAPAN

21	Yasuhiko Kamon	Magnesium deficiency in zoysiagrass

SWEDEN

22	Martin Petersen	Construction of sports grounds based on some physical soil characteristics
23	Sven-Ove Dahlsson	Frit flies (Oscinella frit L.) may cause serious damage to turfgrass

HIGHLIGHTS OF TURFGRASS RESEARCH IN MISSISSIPPI

Coleman Y. Ward
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Institute of Food and Agricultural Sciences
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It is a pleasure to share with you, the participants of the 1974 Texas Turfgrass Conference, some of the major findings of the Turfgrass research program at Mississippi State University. The greatest reward a researcher can have is to see the results of his experimentation put to use. Turfgrass managers and golf course superintendents in particular have inspired my work greatly by rapidly adopting the recommendations which evolved from the turf research at Mississippi State University. My hat is off to a very progressive industry. Because of the need for brevity, only a summary of the presentation made at the Conference is given for the Proceedings.

I. Turfgrass Nutrition

Fertilization is a key factor determining turf quality.

Nitrogen - A decade of research on nitrogen fertilization requirements of turf grasses shows the following:

A. Bermudagrass golf greens require 16 to 24 pounds of N/1,000 square feet per year depending on latitude. The rate needed in the winter season is about 50% of the summer rate.

B. Bermudagrass tees and gridirons need about 10 to 12 pounds of N/1,000 square feet per year. Gridiron turf and baseball infields require 2 pounds monthly in the warm season and 1 pound monthly in late spring and early fall.

C. Lawns, fairways, and similar areas planted to bermudagrass need 3 to 6 pounds annually depending on the quality of turf desired. The higher rate is needed for areas receiving more traffic or on lawns where clippings are removed.

D. Other lawns -

Centipedegrass - 1 to 3 lbs. of N/1,000 sq. ft./year

Zoysiagrass - 2 to 4 lbs. of N/1,000 sq. ft./year

St. Augustine Grass - 3 to 5 lbs. of N/1,000 sq. ft./year

Phosphorous and Potassium - Research with phosphorous and potassium fertilization showed that turfgrasses are healthier when P and K are applied at 1 pound of P_2O_5 equivalent and 2 pounds of K_2O equivalent per each 4 pounds of nitrogen, applied except with centipedegrass which responds best to a 2-1-2 ratio of $N-P_2O_5-K_2O$.

Sulfur - Good responses to sulfur fertilization were obtained on bermudagrass, zoysiagrass and tall fescue. The higher the rate of N applied, the greater the response to added sulfur. A rate of 1 pound per 1,000 square feet annually was adequate. Sulfur sources such as sulfur coated urea, ammonium sulfate, and potassium sulfate were all satisfactory.

Extensive tests on sources of nitrogen for bermudagrass greens show that any N source can be used with good results. Understanding the basic chemistry of the fertilizer is essential to knowing frequency of application, amount per application, effect of soil pH and "burning" potential.

Hybrid bermudagrass and Meyer zoysiagrass managed as lawn, tee or gridiron turfs were subjected to varying intensities of foot traffic and divot injury. Adequate nitrogen fertilization influenced the rate

of recovery and improved wear resistance more than increasing the mowing height.

II. Thatch Control

Thatch is defined as dead, undecomposed leaves and stems of grass between the green leaves and the soil. If the thatch layer becomes too thick, turfs perform poorly. How can thatch be controlled? Our research shows that on golf greens the best single practice for thatch control is periodic topdressing with thin layers of soil (a soil mixture having suitable particle sizes). A second, and good method is core aerification in which the soil from the cores is worked into the turf. Vertical mowing as used in these studies did not reduce thatch effectively.

Vertical mowing turf maintained at lawn heights reduced thatch, but increased the number of weeds present. The best time to vertical mow lawns of warm season grasses is just prior to spring "green up."

III. Mowing

The ideal mowing height for any turfgrass species is dependent on use -- for lawn use we obtained superior turf at the following heights for the grasses shown.

Bahiagrass	2.0"
Bermudagrasses	
Common	1.0"
No-Mow	0.4"
Tifdwarf	0.5"
Tifgreen	0.5"
Tiflawn	1.0"
Tifway	0.6"
Tufcote	1.0"
Centipedegrass	1.2"

St. Augustine	1.5"
Tall Fescue	1.5"
Zoysiagrass	0.5"

All grasses produced superior turf when mowed with a reel mower as compared to a rotary mower.

IV. Overseeding Research

It is a common practice to overseed warm season turfgrasses, especially golf greens, with cool season grasses each fall several weeks prior to frost. Many factors determine the success of these overseedings. Some of the variables studied at Mississippi State University were:

(1) Seeding date - Results from studies repeated for several years show that the ideal seeding date for areas subject to frost by December 1, is about 15 to 20 days prior to the average date of the first killing frost.

For areas with frost dates later than December 1, overseed about November 20.

Overseedings made too early are very subject to loss by diseases such as Phythium and blast. Conversely, if overseedings are made too late, many seedlings are killed by low temperatures.

(2) Seeding rates - A decade or more ago Dr. Marvin Fergeson, formerly Agronomist with the USDA, advocated planting about 25 million seeds per 1,000 square feet when overseeding golf greens. Our research shows this to be good advice, except where ryegrass is the only species seeded, in which case a smaller number of seed is required. Based on our

research, the list below shows the ideal seeding rate, days to emergence and days to establish excellent turf quality for the most commonly used grasses. The rates are based on the use of a single grass species.

Species	Rate Lbs./ 1,000 Sq.Ft.	Days to Emerge	Days for Acceptable Turf
Annual ryegrass	40-50	3-6	20-30
Bentgrasses	4-5	7-14	60-80
Bluegrasses			
Kentucky	10	20-30	90-120
rough	8	10-14	75
Perennial ryegrass	30-40	6-12	25-35
Red fescue	25	10-14	50

Excellent results have been obtained with mixtures of grasses such as, 12 to 15 pounds of red fescue, 4 to 5 pounds of Poa trivialis and 1 to 2 pounds of bentgrass. More recently blends containing equal amounts of perennial ryegrass and red fescue seeded at 30 pounds per 1,000 square feet have produced very good turf quality.

(3) Species - Until perennial ryegrasses came into vogue in the late 60's it was a common practice to seed annual ryegrass alone, or a mixture of two to four finer leafed species.

Since there are several varieties of most species it was not uncommon to have 30 to 50 entries in our overseeding trials each winter. Very briefly, we found the following varieties to perform best for Mississippi conditions. The grasses are

listed in order of superior performance as to species and variety.

(a) Perennial ryegrass; Pennfine, Medalist-4 and Manhattan

(b) Red fescue; Jamestown, Dawson, Atlanta, and Ruby

(c) Poa trivialis; Common

(d) Creeping bentgrass; Seaside, Penncross and Emerald

(e) Annual ryegrass; Magnolia and Common

(f) Kentucky bluegrass; Windsor, Baron and Prato

We did not find Kentucky bluegrass satisfactory alone, nor was it beneficial when added to mixtures.

(4) Seeding and Mowing - Topdressing with a thin layer (3/16") of sand or soil mix improved the stands of overseedings compared to no topdressing treatments. Topdressing applied immediately after seeding was superior to topdressing applied immediately before overseeding.

Delaying mowing of new seedings or initially mowing at a cutting height of 1/2" and gradually lowering the height over a 10 day period did not result in turf superior to daily mowing at 1/4" to 5/16" following seeding.

EFFECTIVENESS OF NEW MATERIALS ON TURF FERTILIZATION AND CHINCH BUG CONTROL

Richard L. Duble and Robert P. Carter

INTRODUCTION

Ferrous Ammonium Sulfate, a fertilizer material taken off the market in the late 1960's, may be back in use if production problems are solved. Ferrous Ammonium Sulfate (FAS) was used in large quantities on turf in the Western United States, where iron deficiency was prevalent. The material produces a dramatic greening response on turf and ornamental plants due to its iron, nitrogen and sulfur content, all of which are deficient in large areas of Texas. FAS has a potential use in turf for promoting a green color without excessive stimulation of growth.

Aspon, an organo-phosphate insecticide, has provided very effective chinch bug control in St. Augustine grass at a rate of 7.3 pounds active per acre. Observations from Aspon treated lawns suggest that much lower rates of application may be equally effective for chinch bug control. Such a rate reduction would result in a considerable savings for homeowners where chinch bug control is required to maintain St. Augustine grass lawns.

Objectives:

1. To measure the greening response of Ferrous Ammonium Sulfate in St. Augustinegrass turf and compare with that of other fertilizer formulations including Ortho Lawn Food.
2. To measure the effectiveness of several insecticides including Ortho Chinch Bug Spray and Ortho Chinch Bug Control on the control of chinch bugs in St. Augustinegrass turf.

Procedure:

Ferrous ammonium sulfate (FAS) was applied at a rate of 6.8 pounds per 1,000ft^2 (equivalent to 1 pound N per 1,000ft^2) and compared with Ortho Lawn Food, Scotts Super Turf Builder, 12-12-12, ammonium sulfate and an unfertilized check. All fertilizers were applied at a rate equivalent to 1 pound N per 1,000 ft^2. The experimental site was a St. Augustine grass lawn that had not received fertilizer for 5 months prior to the initiation of this experiment. The lawn was mowed weekly at a height of 1-1/2" and water was applied as necessary to prevent wilting. Plot size was 10' x 10'. Treatments were completely randomized with 3 replications of each treatment. Fertilizers were applied on April 4, 1974.

Observations were recorded weekly to measure color, density and uniformity. All plots were rated on a scale of 1 to 9 with 9 being dark green, very dense and completely uniform. Lower ratings indicated that the color was lighter green, density was thinner and the response was less uniform than treatments receiving higher ratings. Analysis of variance techniques were used to determine significant differences between fertilizer treatments and between fertilized plots and unfertilized plots.

Ortho Chinch Bug Spray (Aspon liquid) and Ortho Chinch Bug Control (Aspon granular) were applied to St. Augustine grass lawns in Bryan and College Station. Each insecticide was applied at two rates - 3.7 and 7.3

pounds active ingredient per acre. Treatments were applied on June 4 immediately after taking the initial chinch bug counts. All four treatments and an untreated check were included at each of four locations. Plot size ranged from a minimum of 1,000ft^2 to a maximum of 3,000ft^2. The liquid formulation was applied with hose-proportioner in a volume of water equivalent to 15 gallons per 1,000ft^2. The granular formulation was applied with a calibrated gravity-flow distributor. Lawns were watered the day prior to treatment and following the application of the insecticides. Lawns were mowed weekly and watered to prevent severe wilting.

Weekly chinch bug counts were taken by sinking a 5-gallon can (with both top and bottom removed) several inches into the soil, filling the can with water (adding a cap-full of Ortho Multi-purpose Spray) and counting the adult chinch bugs that float to the surface within 5 minutes. At least 3 counts were taken within each treatment at each location and date. Analysis of variance techniques were used to compare treated with untreated plots and to determine significant differences between treatments.

Results and Discussion

The St. Augustine grass lawn responded quite rapidly to fertilizer treatments. At the time the treatments were applied (April 4) the grass had a light green color and within 10 days fertilized plots showed a significant improvement in color (Table 1). Ortho FAS produced the greatest color response of the fertilizers tested and was superior to Ortho Lawn Food at each observation date. Ortho FAS was superior or equal to all fertilizers at each observation date except for Scotts Super Turf Builder at the last date. The color response of all the soluble fertilizers disappeared after 4 weeks. Scotts Super Turf Builder did not produce as great a color response as the soluble materials, but its color response was

longer lasting than for the soluble fertilizers. Ammonium sulfate produced a very similar color response to that of Ortho FAS. Ortho Lawn Food and Scotts Super Turf Builder produced similar responses except that the effect of Scotts was longer lasting.

Density ratings indicated the extent of recovery of the grass from winter dormancy. At the time of fertilization the lawn was about 50% recovered (or 50% green grass) as reflected by the density rating in the unfertilized check plots. Within 10 days after fertilization all treated plots showed significant improvement in density (Table 2). Improvement in density continued for about 3 weeks after fertilization. Ortho FAS produced a significantly greater improvement in density than all other fertilizer treatments. Ammonium sulfate and Scotts Super Turf Builder were significantly better than Ortho Lawn Food and 12-12-12 in terms of density response.

Uniformity observations were based on color, density and growth rate of the individual plots of St. Augustine grass. A low rating would indicate that the distribution or response was not uniform throughout the plot. Again, Ortho FAS and ammonium sulfate produced a significantly more uniform response than other treatments (Table 3). Iron chlorosis which occurs in erratic spots throughout the lawn was responsible for most of the non-uniform ratings. Thus, the sulfur present in Ortho FAS and ammonium sulfate plus the iron present in Ortho FAS may have made iron more available to the grass and produced a significantly more uniform appearance. Scotts Super Turf Builder, Ortho Lawn Food and 12-12-12 produced a significantly more uniform turf than the unfertilized check.

Considering general turf appearance as a combination of color, density and uniformity. Ortho FAS produced attractive St. Augustine grass for a

period of one month after application at a rate equivalent to 1 pound of nitrogen per 1,000 ft^2. The general appearance of turf fertilized with Ortho FAS and ammonium sulfate was superior to that produced by all other fertilizers included in this test. The superiority of FAS and ammonium sulfate over the other fertilizers on St. Augustine grass could probably be contributed to the sulfur and iron that FAS and ammonium sulfate contain. Monthly applications of these materials at rates equivalent to 1 pound of nitrogen per 1,000 ft^2 would produce attractive St. Augustine grass turf throughout the summer. However, phosphorus and potassium fertilizers would be needed in the fall.

At the time the chinch bug control treatments were made (June 4), chinch bug populations averaged 19 adults per square foot. This population declined slightly and then increased significantly by the end of the 8-week observation period in untreated check plots. Lawns did not show chinch bug damage at the beginning of the observation period, but untreated plots had large patches of dead St. Augustine grass by mid-July. Treatment with Ortho Chinch Bug Control and Ortho Chinch Bug Spray at rates of 3.7 and 7.3 pounds active ingredient per acre effectively reduced the chinch bug population for 8 weeks (Table 4). At the end of the 8-week observation period, winged adult chinch bugs were beginning to reinfest the treated lawns, but no nymphs were found in treated lawns. Apparently the residue was low enough at 8 weeks after treatment to allow the adults that migrated from neighboring lawns to survive. Based on earlier observations 3 to 5 additional weeks would be required for the population to reach damaging levels. In this investigation, there was not a significant difference between rates of application or formulations used. Both rates and formulations provided effective control during the 8-week period.

Rainfall throughout the test area was less than 1.0 inch during the 8-week period, but lawns were watered regularly to maintain growth. Daytime temperatures were above 90°F and night temperatures were between 70° and 75°F. Thus, environmental conditions were very favorable for chinch bugs as indicated by the untreated check plots.

Table 1. Color response of St. Augustine grass to FAS and other fertilizer materials, College Station, Texas, 1974.

Treatment	Color*					
	4-14	4-23	4-30	5-7	5-14	Average
Ortho FAS	7.0†	7.0	8.0	6.0	4.7	6.5 a‡
Ortho Lawn Food	6.0	5.7	6.3	5.7	4.3	5.6 b
Ammonium sulfate	7.0	7.0	7.0	6.0	4.0	6.2 ab
12-12-12	6.3	5.3	6.7	5.0	4.3	5.5 b
Scotts Super Turf Builder	6.3	5.7	6.7	5.7	5.3	5.9 ab
Check	4.0	4.3	5.3	4.7	4.3	4.5 c

* Ratings are based on a scale of 1 to 9 with 9 being very dark and 1 being yellow.

† Values shown are the average of 3 replications.

‡ Values followed by the same letter are not significantly different at the .05 level by Duncans Multiple Range Test.

Table 2. Density of St. Augustine grass turf as influenced by FAS and other fertilizers, College Station, Texas, 1974.

Treatment	Density*				
	4-14	4-23	4-30	5-7	Average
Ortho FAS	6.0†	7.0	7.3	6.0	6.6 a‡
Ortho Lawn Food	5.0	4.7	6.3	5.0	5.2 c
Ammonium sulfate	6.0	6.0	6.7	5.7	6.1 b
12-12-12	5.3	5.3	5.7	4.7	5.2 c
Scotts Super Turf Builder	5.7	5.7	7.0	5.3	5.9 b
Check	4.3	4.3	5.3	4.3	4.6 d

* Density ratings are based on a scale of 1 to 9 with 9 being very dense and 1 being very thin.

† Values shown are the average of 3 replications.

‡ Values followed by the same letter are not significantly different at the .05 level by Duncans Multiple Range Test.

Table 3. Uniformity of St. Augustine grass as influenced by FAS and other fertilizer materials, College Station, Texas 1974.

Treatment	Uniformity*				
	4-14	4-23	4-30	5-7	Average
Ortho FAS	6.3†	7.0	7.3	5.3	6.5 a‡
Ortho Lawn Food	5.3	6.0	6.3	5.3	5.7 b
Ammonium Sulfate	6.0	6.3	7.7	6.0	6.5 a
12-12-12	5.3	5.3	6.3	5.3	5.6 bc
Scotts Super Turf Builder	5.7	6.0	6.0	5.0	5.7 b
Check	5.0	5.7	6.0	4.7	5.3 c

* Uniformity ratings are based on a scale of 1 to 9 with 9 being very uniform and 1 being non-uniform.

† Values shown are the average of 3 replications.

‡ Values followed by the same letter are not significantly different at the .05 level according to Duncan's Multiple Range Test.

Table 4. Chinch bug counts in St. Augustine grass turf as influenced by liquid and granular formulations of Aspon at two rates of application, Bryan-College Station, Texas, 1974.

Location*	Treatment†	Adult Chinch Bugs per Sq.Ft.‡						
		Weeks after Treatment						
		0	2	3	4	6	7	8
1	1	24	0	0	0	0	0	2
	2	24	0	0	0	0	3	2
	3	24	0	0	0	0	3	3
	4	24	0	0	0	0	0	4
	5	24	20	10	16	47	35	43
2	1	20	0	0	0	0	3	11
	2	20	0	0	3	1	14	14
	3	20	0	0	0	0	0	3
	4	20	1	0	0	0	3	6
	5	20	18	26	32	43	49	49
3	1	19	1	0	0	0	0	3
	2	19	5	1	1	1	3	8
	3	19	0	0	0	0	0	1
	4	19	0	0	0	0	0	4
	5	19	17	5	18	40	39	36
4	1	14	0	0	0	0	0	0
	2	14	0	0	0	0	0	0
	3	14	0	0	0	0	0	0
	4	14	0	0	0	0	0	2
	5	14	23	19	17	35	47	39
Average	1	19	0	0	0	0	1	4
	2	19	1	0	1	1	7	6
	3	19	0	0	0	0	1	2
	4	19	0	0	0	0	1	4
	5	19	19	15	21	43	41	42

* Locations 1 - 4 represent lawns in the Bryan-College Station area.

† Treatments 1 - 5 are defined as follows:
1 - Ortho Chinch Bug Control at 7.3 lbs. ai/acre
2 - Ortho Chinch Bug Control at 3.7 lbs. ai/acre
3 - Ortho Chinch Bug Spray at 7.3 lbs. ai/acre
4 - Ortho Chinch Bug Spray at 3.7 lbs. ai/acre
5 - Untreated Check

‡ Values represent the average of 3 counts.

Pre-Emerge Herbicides for Weed Control During Turfgrass Establishment

R. L. Duble

Weeds present a serious problem during the establishment of turfgrasses from vegetative materials. Broadleaf weeds and annual grasses compete with sprigs and plugs of desirable grasses during the first year. Pre-emerge herbicides have not been recommended because of their injury to new plantings of turfgrasses. Post-emerge herbicides are effective, but repeated applications are generally required for effective control and they, too, are somewhat phytotoxic to turfgrasses.

In order to screen new herbicides for possible use during the establishment of turfgrasses, three grasses, St. Augustine grass, Tifgreen and Tifway bermudagrasses, were planted in 12,000 ft^2 blocks on March 21, 1974. Grasses were sprigged in 10" rows with a Beck Lawn-O-Matic planter at a rate of 5 bushels of sprigs for 1,000 ft^2.

Herbicide treatments shown in Table 1 were applied with a 3-foot gravity flow distributor or a 5-foot boom sprayer on March 27, 1974. Herbicides were applied in 3- or 5-foot strips across all three grasses. Individual plots were 3' x 40' or 5' x 40', depending on whether the herbicide was a granular or wettable powder formulation, respectively. Grasses were planted in 40' by 300' blocks. Three replications of each herbicide treatment was included in a randomized block design.

Weed counts were made 30 and 60 days after herbicide treatments were applied. All weeds in a 2' x 2' frame were counted by species. Three counts were taken in each plot. In addition, percent turfgrass cover was measured 30, 60 and 90 days after treatment to determine any phytotoxicity the herbicides might have had on the grasses.

Results and Discussion

Several general conclusions may be drawn from the information in Tables 2, 3 and 4. First, pre-emerge herbicides, in general, retarded the rate of cover of all three turfgrasses, St. Augustine grass and Tifway and Tifgreen bermudagrasses. Second, St. Augustine was more sensitive to the herbicides than bermudagrass, and Tifgreen was more sensitive than Tifway bermudagrass. Third, none of the pre-emerge herbicides significantly increased the rate of cover of the turfgrasses during the 90 day experimental period. However, later observations indicated that herbicides decreased the time required for St. Augustine to cover. Since St. Augustine was much slower to cover than bermudagrass, weeds had more time to compete with the St. Augustine.

More specifically, Furloe CIPC-124, Probe and Destun which provided good weed control significantly retarded the rate of spread of all three turfgrasses. Destun was completely unsatisfactory with respect to its effect on the rate of spread of the turfgrasses. However, it provided the best weed control of all herbicides included in the study. Previous work with Destun indicated that it was not phytotoxic to established St. Augustine and bermudagrass turf when applied at 4 lbs. active per 1,000 ft^2. Furloe CIPC-124 and Probe provided excellent weed control and only slightly retarded the rate of spread of the turfgrasses. Weed control by the other herbicides was generally poor with the exception of the high rate of Ronstar which provided good weed control. Also, Kerb provided excellent control of annual bluegrass, Poa annua.

In this investigation Poa annua had germinated and was in the 3 to 5 leaf stage at the time the herbicides were applied. Thus, only the herbicides that demonstrate post-emerge activity showed Poa annua control. Weeds included in the counts under the heading others included nutgrass,

purslane, mustards, pigweed and knotweed. Thus, herbicides such as Destun and Probe that demonstrated good control of these weeds had a broad spectrum of herbicidal activity.

Table 1. Herbicide treatments applied 6 days after sprigging 3 varieties of turfgrasses, College Station, Texas, 1974.

	Herbicide*	Formulation	Rate (lbs. active/acre)
1	Furloe CIPC-124	2% Granular	3
2	Furloe CIPC-124	2% Granular	6
3	PPG-139	5% Granular	10
4	Probe	5% Granular	1
5	Probe	5% Granular	2
6	Probe	5% Granular	3
7	Destun	50% WP	2
8	Destun	50% WP	4
9	Destun	50% WP	8
10	Tolban	2% Granular	3
11	Tolban	2% Granular	6
12	Ronstar	2% Granular	2
13	Ronstar	2% Granular	4
14	Amex-820	2.3% Granular	4
15	Amex-820	2.3% Granular	8
16	Dacthal	Flowable (6 lbs./gal)	10.5
17	Dacthal	75% WP	10.5
18	Balan	2.5% Granular	3
19	Kerb	50% WP	1
20	Check	-----	-
21	Probe	Flowable (4 lbs./gal.)	2

* All granular formulations of herbicides were applied March 27, 1974. All WP and Flowable formulations were applied April 2, 1974.

Table 2. Effect of pre-emerge herbicides on the rate of cover of Tifway bermudagrass, College Station, 1974.

Herbicide (See Table 1)	Percent Cover 4/23	5/23	6/22	Mean
1	3.9	50.1	81.7	45.2 bcd
2	3.2	52.4	81.7	45.8 bcd
3	3.2	55.4	95.0	51.2 abcd
4	5.6	61.1	91.7	52.7 ab
5	5.0	56.4	86.7	49.4 bcd
6	3.1	43.7	91.7	46.1 bcd
7	6.8	40.2	76.7	41.2 de
8	3.8	38.6	53.3	31.9 f
9	2.4	22.9	36.7	20.7 g
10	6.9	67.4	85.0	53.1 ab
11	5.2	58.3	86.7	50.1 bcd
12	4.3	56.7	85.0	48.7 bcd
13	4.4	61.1	90.0	51.8 abc
14	3.4	67.2	95.0	55.2 ab
15	3.3	56.7	91.7	50.6 bcd
16	4.4	70.6	93.3	56.1 ab
17	3.3	48.6	86.7	46.2 bcd
18	3.6	70.9	91.7	55.4 ab
19	5.0	80.9	95.0	60.3 a
20	5.8	73.0	98.3	59.3 a
21	3.0	50.6	88.3	47.3 bcd
Average	4.3	55.1	84.8	

Table 3. Effect of pre-emerge herbicides or the rate of cover of St. Augustine grass, College Station, Texas, 1974.

Herbicide (See Table 1)	Percent Cover 4/23	5/23	6/22	Mean
1	0.7	12.1	23.3	12.0 fg
2	0.8	10.8	18.3	9.9 ghi
3	1.0	23.9	33.3	19.4 ab
4	1.2	10.9	30.0	14.0 defg
5	1.7	9.6	11.7	7.6 hig
6	0.4	3.0	10.7	4.7 jk
7	2.0	12.4	21.7	12.0 fg
8	2.0	6.4	10.0	6.1 ijk
9	1.4	3.0	4.3	2.9 k
10	2.0	19.6	33.3	18.3 abcd
11	1.0	15.6	26.7	14.4 cdef
12	1.6	11.1	25.0	12.6 efg
13	2.3	15.9	31.7	16.6 bcde
14	2.7	16.8	30.0	16.5 bcde
15	2.4	23.1	31.7	19.1 ab
16	2.8	21.4	31.7	18.3 abcd
17	2.4	24.9	28.3	18.6 abc
18	2.7	15.3	33.3	17.1 bcd
19	2.1	32.8	31.7	22.2 a
20	3.0	20.2	35.0	19.4 ab
21	0.4	13.0	18.3	10.6 fgh
Average	1.7	15.3	24.8	

Table 4. Effect of pre-emerge herbicides on the rate of cover of Tifgreen bermudagrass, College Station, Texas, 1974.

Herbicide (See Table 1)	Percent Cover 4/23	5/23	6/22	Mean
1	1.6	41.8	66.7	36.7 gh
2	0.1	21.8	63.3	28.4 i
3	6.9	53.0	100.0	53.3 abc
4	3.4	66.1	100.0	56.5 ab
5	2.7	51.1	93.3	49.0 bcde
6	1.4	19.7	70.0	30.4 hi
7	2.7	29.3	65.0	32.3 hi
8	0.7	13.0	31.7	15.1 j
9	0.1	3.0	15.0	6.0 k
10	2.0	74.3	100.0	58.8 a
11	1.9	62.8	96.7	53.8 abc
12	3.0	72.8	90.0	55.3 ab
13	1.3	31.1	91.7	41.4 efg
14	2.3	76.1	96.7	58.4 a
15	1.1	43.0	95.0	46.4 cde
16	1.3	41.2	81.7	41.4 efg
17	1.0	55.9	88.3	48.4 bcde
18	2.2	65.7	85.0	51.0 abcd
19	1.9	48.6	83.3	44.6 def
20	3.6	72.0	96.7	57.1 ab
21	4.0	50.1	93.3	49.1 bcde
Average	2.1	46.2	81.1	

Table 5. Weed control in newly sprigged turfgrasses by pre-emerge herbicides, College Station, Texas, 1974.

Herbicide (See Table 1)	Weeds Per 40 Square Feet			
	P. annua	Barnyardgrass	Bracharia	Others
1	3 abc	2 a-d	8 e-i	13 b-e
2	0 a	1 abc	6 c-g	7 abc
3	107 a	12 g	25 j	33 h
4	16 cd	5 ef	7 d-i	9 a-d
5	1 ab	1 abc	3 a-e	10 a-d
6	0 a	1 abc	2 a-d	10 a-d
7	14 bcd	0 a	2 a-d	8 abc
8	3 abc	0 a	1 abc	9 a-d
9	0 a	0 a	0 a	3 a
10	54 gh	3 c-f	5 b-g	24 fg
11	21 de	3 b-f	4 a-f	9 a-d
12	34 ef	6 f	3 a-e	16 c-f
13	22 de	1 abc	2 a-d	9 a-d
14	60 h	4 def	9 f-i	13 b-e
15	30 ef	2 a-d	12 i	21 efg
16	43 fg	3 b-f	10 ghi	10 a-d
17	39 f	2 a-d	4 a-f	27 gh
18	44 fg	2 a-d	6 c-h	23 fg
19	3 abc	4 def	6 c-g	19 d-g
20	83 i	14 g	11 hi	23 efg
21	5 abc	2 a-d	3 a-e	6 ab
Average	27	3	7	10

Table 5. Phytotoxicity of preemerge herbicides to bermudagrass turf following fall applications in College Station, 1973.

Herbicide	Rate (lbs./acre)	Phytotoxicity* Fall	Spring
VCS-438 (Probe)	1	4.0	0.5
VCS-438 (Probe)	2	6.5	0.5
VCS-438 (Probe)	3	7.0	1.0
Balan	3	0.5	0.5
Dacthal	12	1.0	0.5
Rowtate	3	4.0	1.5
RP-17623 (Ronstar)	2	1.0	0.0
Destun	4	2.0	1.0
Furloe CIPC-124	2	1.0	2.0
Furloe CIPC-124	4	1.5	3.0
Check	-	0.0	0.0

* Ratings are based on a scale of 0 to 9 with 0 being no visible damage and 9 being severe damage. Fall observations were taken November 15 and were based on degree of discoloration. Spring obersvations were based on recovery of bermudagrass following dormancy.

An Evaluation of Various Cool-Season Grass Mixtures in Overseeding a Tifgreen-Tifdwarf Bermudagrass Putting Green

R. L. Duble, Don Johns and Phil Ramsey

INTRODUCTION

Overseeding bermudagrass putting greens with cool-season grass species during the winter season when bermudagrass enters dormancy over large areas of its' range has become almost a mandatory practice on golf courses so affected.

In fact a 1968 survey by Paul M. Alexander, Turfgrass Times, volume 3, number 8, showed that over 91% of the golf courses he contacted in six southern states overseeded.

This practice is accomplished to provide the golfer with a more suitable playing surface while maintaining an aesthetically pleasing green color.

A particular grass species or grass mixture is not used exclusively. Many overseeded winter grasses may satisfy the qualities of rapid germination, heavy traffic tolerance, good putting surface, good color, good Spring transition, disease resistance, and low seed cost.

For the purposes of this evaluation six different mixtures were rated, the ultimate criterion being putting surface quality.

PROCEDURE

This experiment was conducted during the fall, 1973, on an established one-half Tifgreen, one-half Tifdwarf bermudagrass putting green located at the Turfgrass Research Plots, Texas A&M University campus. The cool-season grass mixtures evaluated and their seeding rates are listed in Table I.

These mixtures were composed of perennial ryegrass (Lolium perenne L.), red fescue (Festuca rubla L.), creeping bentgrass (Agrostis palustris Huds.), and Kentucky bluegrass (Poa pratensis L.). Specifically, the formulations were Medalist 2 (a combination of NK-100 and Pelo); Medalist 4 (NK-200 and Pennfine); Dixiegreen (perennial ryegrass and fine fescue); Northrup, King and Company's B-100 (55% NK-200, 40% Dawson red fescue, 5% Seaside creeping bentgrass); B-200 (55% NK-200, 30% Dawson, 15% Prato Kentucky bluegrass); and B-300 (65% NK-200, 30% Prato, 5% Seaside).

The green was vertically mowed in several directions prior to overseeding, which was accomplished on November 7. Seeds were distributed uniformly over the 1,000 square foot plot areas at the designated rates (Table I) by a gravity-flow type seeder.

The area was then topdressed with approximately 1/8 inch of sand, using a power-driven topdressing spreader. Following topdressing, the plots were watered lightly and kept moist until emergence.

The overseeded grasses were initially mowed at a height of 3/8 inches; however, the mowing height was ultimately lowered to 1/4 inch and maintained at this level.

On December 4, the entire green was fertilized with Milorganite at a rate of one pound of actual nitrogen per 1,000 square feet.

Performance ratings were determined visually. Those factors evaluated were color, density, uniformity and putting surface quality which encompasses density. Grasses were ranked from 1 to 6 for each of these characteristics with 1 being superior. Emergence rates were also considered.

RESULTS

The Medalist mixtures were the most rapid to germinate, and initially were the superior test strains (Table 2).

Texture did not become a major factor in either the appearance or quality of the putting surface during the evaluation period.

Color ratings were variable over the observation period, and again the Medalist mixtures were initially more appealing; whereas, B-100, B-200 and B-300 plots were superior at the conclusion of observations (Table 3).

Putting surface ratings were based on personal preference and considered primarily from the standpoint of turfgrass density and uniformity.

Several characteristics of the grass mixtures influenced their rankings as the season progressed. Those that were predominantly ryegrass covered first, but those with bentgrass became the most dense as the season progressed. The bentgrass and red fescue contributed to improved putting quality of the ryegrasses.

Generally, the Medalist 2 and Dixiegreen formulations performed poorly throughout this study; Medalist 4 was intermediate in all respects; and the B-100, 200, 300 mixtures were superior in all respects with the exception of rate of emergence.

Table 1. Grass and grass mixtures included in overseeding studies, College Station, Texas 1973.

Variety or Mixture	Components	Seeding Rate lb/1,000ft^2
Dixiegreen	Perennial ryegrass-fine fescue	45
Medalist 2	NK-100 and Pelo perennial ryegrasses	45
Medalist 4	NK-200 and Pennfine perennial ryegrasses	45
B-100	NK-200 (55%), Dawson red fescue (40%), Seaside bent (5%)	36
B-200	NK-200 (55%), Dawson (30%) Prato Kentucky bluegrass (15%)	40
B-300	NK-200 (65%), Prato (30%) Seaside (5%)	32

Table 2. Rate of emergence, texture, color and putting quality of grasses and mixtures used for overseeding golf greens, College Station, Texas, 1973.

Variety	Significant emergence (days after planting)	Color	Texture	Putting Quality
Dixiegreen	7	Light green	Medium	5-6
Medalist 2	5	Light green	Coarse	5-6
Medalist 4	6	Dark green	Coarse	4
B-100	8	Dark green	Med-fine	1
B-200	9	Medium green	Medium	3
B-300	9	Medium green	Med-fine	2

Table 3. Color density and uniformity of grasses and mixtures used to overseed bermudagrass, College Station, Texas, 1974.

	Dates of Observation	Dixie Green	Medalist 4	B-100	Medalist 2	B-200	B-300
COLOR	11/13	6	-	-	5	2	3
	11/20	5	4	1	6	2	3
	11/26	5	3	1	6	2	4
	12/7	5	4	1	6	2	3
	12/21	6	2	1	5	3	4
	1/17	6	4	1	5	2	3
	2/21	5	2	1	6	4	3
	3/19	6	3	1	5	4	2
DENSITY	11/13	2	3	6	1	4	5
	11/20	5	3	4	2	1	6
	11/26	3	2	4	5	1	6
	12/7	5	4	3	6	2	1
	12/21	5	4	3	6	2	1
	1/17	5	4	3	6	1	2
	2/21	5	4	1	6	3	2
	3/19	5	4	1	6	3	2
UNIFORMITY	11/13	-	-	-	-	-	-
	11/20	-	-	-	-	-	-
	11/26	-	-	-	-	-	-
	12/7	5	4	3	6	2	1
	12/21	5	4	3	6	2	1
	1/17	5	4	3	6	1	2
	2/21	5	4	1	6	3	2
	3/19	5	4	1	6	3	2

Varieties were ranked from 1 to 6 within each date of observation with 1 being best and 6 being poorest.

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