James B. Beard

PROCEEDINGS OF THE 20TH ANNUAL NORTH CAROLINA TURFGRASS CONFERENCE

Volume III

January 13-14, 1982

Raleigh, N. C.

Sponsored by

Turfgrass Council of North Carolina

North Carolina State University

North Carolina Agricultural Extension Service

PREFACE

Proceedings of the 20th Annual North Carolina Turfgrass Conference are being provided to those who attended the conference to serve as a permanent reference of the many presentations. The 1982 conference was held at the Royal Villa Hotel in Raleigh, NC on January 12, 13 and 14. Concurrent sessions for golf courses, lawn care, and general turfgrass topics were given at the conference. The attendance of 450 persons resulted in a very successful conference.

Special thanks are extended to all persons whose efforts made this conference a great success. Each speaker is to be commended for his excellent presentation and for providing a written summary for these proceedings. The Annual Turfgrass Conference is sponsored by the Turfgrass Council of North Carolina, Inc., North Carolina State University, and the North Carolina Agricultural Extension Service in cooperation with the Turfgrass Associations. The efforts of the following committees contributed to the success of the Conference.

Conference Chairman - W. B. Gilbert

Program Co-Chairmen - Leon Lucas and Gary Stafford

Program Committee

Bill Anderson	Harry DuBose	Bill Johnson
Carl Blake	J. B. Elkins	P. J. Lenihan
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Advertisments and Printing of Programs

Bob Hamrick

The 1983 Turfgrass Conference will be held in Pinehurst, NC in January.

PROCEEDINGS EDITORS: L. T. Lucas and J. M. DiPaola

Printed May 1982

Additional copies of these proceedings are available at $5.00 each from Dr. L. T. Lucas, Department of Plant Pathology, N.C. State University, Raleigh, NC 27650. Make checks payable to The Turfgrass Council of North Carolina.

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FUTURE OF THE NORTH AMERICAN TURFGRASS INDUSTRY

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It is impossible to forecast future events with complete accuracy. It is, however, possible to guess as to what probably will happen in response to present trends and changes that are likely to take place.

Several obvious factors will influence the turfgrass industry: changes in the availability and cost of energy, increased population and further expansion of urban centres, decreased availability of water, better species and cultivars, different approaches to pest control and turf management. In addition, I expect that the industry will be affected one way or another by changing life styles and work habits, the expected increase in the proportion of the population over 65, increased government regulations, and by new technology.

Better management is the key to future success in the Turfgrass Industry. There is an almost overwhelming amount of information that each manager needs to fit together into a comprehensive package for his own operation. Fortunately, we now have available relatively low-cost medium capacity computers - and this technology is advancing extremely rapidly. It is likely that all parts of the Turfgrass Industry will become dependant on computer assistance in the very near future.

The Universities, Colleges and Research Stations will become increasingly important to the Turfgrass Industry in the future. Managers will have to be better educated in order to cope with the increased pressures that will be placed on the industry. More continuing education programs, as well as the standard University and College programs, will be made available. Research on new species and cultivars, pest management, irrigation and drainage, soil fertility, and in many other fields will be essential to the Industry.

The future of the Industry depends on how well the "man in the street" understands the value of turfgrass. Each of us who know something of the importance of parks, lawns and golf courses to our society has an obligation to inform others at every opportunity. If we are successful in communicating this information, we will guarantee a bright future for the North American Turfgrass Industry.

Presented to the 20th Annual North Carolina Turf Conference, Raleigh, N.C., January 12, 1982.

CHARACTERISTICS OF TURFGRASS FERTILIZERS

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Fertilizer can be defined as any organic or inorganic material of natural or synthetic origin that is added to a soil to supply one or more elements essential to the growth of plants. The quantity of plant nutrient elements needed, in addition to the amount supplied by the soil, to increase plant growth or quality to a designated level is called the fertilizer requirement. The fertilizer requirement is influenced by the plant being grown as well as the level of available nutrients in the soil. Thus different fertilizers are available to cover a rather wide range of soil and crop conditions.

A fertilizer material is a substance or compound that contains one or more essential elements. Examples are diammonium phosphate, which contains both N and P, and urea, which is a source of N. Mixed fertilizers contain two or more fertilizer materials, and a complete fertilizer contains all three of the essential fertilizer elements: nitrogen (N), phosphorus (P), and potassium (K).

Mixed fertilizers can be manufactured, blended, or fluid fertilizers. A manufactured fertilizer is one in which some of the materials react chemically to form new compounds: e.g. ammonia and phosphoric acid react to form ammonium phosphates. Manufactured fertilizers are usually granular (as opposed to pulverized) and some are referred to as being homogenous because each granule ideally has the same chemical composition. Blends are dry mixtures of fertilizer materials. An example would be a mixture of urea, superphosphate, and muriate of potash. Blending is a much simpler process and involves simpler equipment than is the case with manufactured fertilizers. A disadvantage to blends is segregation of materials, which can occur in piles, bags, trucks, or as it is spread. Sizes and densities of materials should be similar to minimize segregation. Also, it is difficult to apply small amounts of micronutrients or pesticides throughout a blend. Fluid fertilizers may be in the form of a solution (all components soluble in water), suspension, or slurry. Fluid fertilizers are easy to transport, handle, and apply. They are well suited for micronutrient and pesticide application. Many commercial lawn care companies use programs based on fluid applications.

Any fertilizer available can be applied to a turfgrass stand, but does this make it a 'turfgrass' fertilizer? Probably not, because a turfgrass fertilizer would be better defined as a fertilizer that has been formulated specifically for turfgrass use. The needs of turfgrass plants and characteristics of turfgrass areas can be taken into consideration in the development of such fertilizers. Most

suppliers will offer a range of turfgrass fertilizers to meet the needs of various turfgrass areas. Even though there is variation among turfgrass fertilizers, these fertilizers, as a group, have chemical and physical differences that set them aside from the common farm-type fertilizers.

Most turfgrass fertilizers contain all three of the essential fertilizer elements (N, P, and K) and therefore would be classified as complete fertilizers. The guaranteed analysis of a fertilizer is referred to as the fertilizer grade. The grade is expressed as the percentages of N, P_2O_5, and K_2O. Fertilizer ratios are used to indicate the relative amounts of N, P_2O_5, and K_2O. Turfgrass fertilizers are characterized by grades that have more N than P_2O_5 or K_2O. Examples are 10-5-5, 20-5-10, and 12-4-8. Corresponding ratios are 2-1-1, 4-1-2, and 3-1-2. A 31-3-10 grade would have a ratio of roughly 10-1-3. Some starter fertilizers made for turf have higher amounts of P_2O_5 than N and K_2O, but fertilizers for turfgrass maintenance will be highest in N. These turf grades contrast to the 5-10-5, 8-16-16, or 10-10-10 grades (1-2-1, 1-2-2, or 1-1-1 ratios) that are commonly used for farm and garden fertilizers.

Sources of slow-release nitrogen are usually present in turfgrass fertilizers. Thus these fertilizers will contain both soluble and insoluble (or controlled release) nitrogen. Reasons for including slow-release N sources include a longer lasting effect and a reduced chance of fertilizer burn. The amount of the total N that is water insoluble should be known so that the fertilizer can be used properly. The water insoluble N (WIN) is listed on the label as the percentage of the WIN in the fertilizer, and this value is often confusing to many users. The percentage of the total N that is water insoluble can be calculated using the following formula:

$$\% \text{ of total N that is WIN} = \frac{\% \text{ WIN (label)}}{\% \text{ Total N (label)}} \times 100$$

For example, consider a 10-5-5 fertilizer having 75% of the nitrogen from ureaform (a slow-release N source) and 25% from soluble sources, and having a label indicating a guaranteed analysis of

Total N 10%
5% WIN.

Both values refer to percentages by weight in the fertilizer. Thus a 50-pound bag would contain 5 pounds of total N and 2.5 pounds of WIN, which is part of the total N. Using the percentages values, the percentage of WIN in the total N would be calculated as follows:

$$\frac{5 \text{ (WIN)}}{10 \text{ (Total N)}} \times 100 = 50\%$$

One may wonder why only 50% of the total N is WIN, when 75% of the N came from ureaform. Inspection of a ureaform label will show that all of the N in ureaform is not WIN. A total N value of 38% and 27% WIN indicate that 71% of the total N is water insoluble:

$$\frac{27\ (\text{WIN})}{38\ (\text{Total N})} \times 100 = 71\%$$

If 75% of the N in the 10-5-5 is ureaform-N and 71% of ureaform-N is WIN, the % WIN in the fertilizer can be calculated to be 5.3% (guaranteed at 5%).

One may also note differences in the potassium source used in some turf fertilizers. In some cases sulfate of potash (K_2SO_4) is used rather than muriate of potash (KCl), the more conventional K source. The sulfate salt, having a lower salt index, has about only one-half of the burn potential of muriate of potash. The benefit of this lower salt index is of particular importance in fertilizers formulated for use on dense, close-cut turf areas where fertilizer particles may be held up in the foliage where they may more easily cause salt injury.

Not only do turfgrass fertilizers have some unique chemical properties, but there are also certain physical characteristics that should be of importance to users. Most manufacturers of turfgrass fertilizers offer products that are of relatively uniform particle size and free of dust or hard lumps. They flow readily from spreaders with no bridging or clogging, thus allowing for quick, easy, and uniform application. Products with finer granules are available for use on close cut turf where mower pickup may be a problem. For those wanting to make fluid applications, there are ample materials available to provide a range of ratios and N sources.

Both manufactured and blended fertilizers are available for use on turfgrass. The homogenous feature of manufactured granular fertilizers is sometimes heavily emphasized in advertising literature; however, I am not aware of any proven agronomic advantage over blends that have been prepared using materials of similar sizes and densities to minimize segregation during handling, transportation, and application. A poorly prepared blend applied with a spinner-type spreader may result in uneven application of materials, which can be reflected by non-uniform response across a turf area. Poorly prepared blends or manufactured fertilizers with dusty or lumpy properties may cost less for a given fertilizer grade, but in the long run a fertilizer with good physical properties and spreading characteristics should be worth the additional cost.

Another physical property that varies among turfgrass fertilizers is the density, which is usually expressed as the weight (in pounds) of one cubic foot. Most manufactured and blended fertilizers have densities that fall into range of 50 to 60 lb./cu. ft. Those with fine granules may have a higher density. In contrast to these fertilizers, which are referred to with terms such as normal weight, full weight, or high density, are the lightweight fertilizers. Lightweight fertilizers have the plant nutrients impregnated or carried on low density (lightweight) carriers such as vermiculite, ground corncobs, or synthetic foams. The lightweights usually have nitrogen contents of 20% or higher, so a relatively small weight is required to fertilize a given area. The use of a lightweight carrier gives bulk to the products, and thus increases the volume applied to obtain a given weight of fertilizer. The increased volume eases calibration with drop-type spreaders, allows one to more easily see where material has been spread (minimizing skips and overlaps), and gives more complete coverage of the turf surface (an important factor when fertilizer-herbicide combinations are used). Lightweights are commonly marketed as homeowner products, whereas the high density or normal weight fertilizers are common in professional product lines. The high density products are better suited for spreading with the centrifugal (spinner) type spreaders often used by professionals. The broadcast width is reduced considerably when lightweights are used in these spreaders.

In summary, turfgrass fertilizers have both chemical and physical characteristics that set them apart from normal farm and garden fertilizers. The fertilizer ratios of turf fertilizers indicate a higher proportion of N to P_2O_5 and K_2O, and a portion of the N often comes from a slow-release N source. Use of slow-release N gives a longer lasting effect and reduces the chance of fertilizer burn. Sulfate of potash is often used instead of muriate of potash as a source of K, because it has a lower salt index and its use lowers the risk of fertilizer burn. Both manufactured and blended fertilizers are made for turf use, and in good quality products of both types particular attention is given to obtaining a particle size that will insure rapid and even distribution. Lightweight fertilizers are common in the homeowner line of turfgrass fertilizers.

EFFECTS OF LIME AND TYPES AVAILABLE

Dr. Jack V. Baird

Soils in North Carolina are highly weathered (or leached) due to generally excessive rainfall during winter months. This weathering process causes dissolving of lime and leaching of the calcium and magnesium deeper into the soil contributing to the continual development of surface soil acidity. This is reflected in a gradual lowering of pH each year. Often times, particularly on greens, the high rate of nitrogen use augments the rate of acidity development.

It is assumed that superintendents and turf management personnel realize the need for lime through soil test and an understanding of the weathering processes. On the other hand, it would be advisable to review the benefits of proper liming. Proper liming is meant to imply the application of liming materials based on soil test information. Benefits of liming will be spelled out in the following statements.

Reduction of Toxic Aluminum and/or Manganese

As the soil pH through weathering declines, soil aluminum and in the Piedmont regions, soil manganese becomes dissolved out of the clay minerals. These two elements with decreasing pH can become toxic to plants and cause suppressed growth. Generally speaking, grasses are less sensitive to a given level of aluminum and/or manganese than legumes are.

More Efficient Use of Fertilizer Phosphorus

As indicated above, with declining pH there is an increase in soluble aluminum and manganese coming into the soil solution. Aluminum particularly at low pH's is very active chemically and will tend to combine with fertilizer from the phosphorus application and cause it to be precipitated or made quite insoluble. This essentially irreversible tie-up of fertilizer phosphorus means that less is available to the turf in subsequent growing seasons. In some instances fertilizer has been inadvertently serving as a liming material in that it has immobilized aluminum. This is a very expensive way of dealing with toxic aluminum and manganese.

Best Source of Magnesium

If dolomitic limestone (that containing magnesium) is used, this form will supply an economical source of magnesium essential for greenleaf development. Furthermore, the magnesium supplied in dolomitic limestone is released slowly over a period of 3 to 4 years and is protected from leaching in a more efficient way than that supplied by fertilizer sources of magnesium.

Improved Nodulation of Legumes

On fairways, particularly, or other turf where legumes are accepted as part of the turf, adequate soil pH is necessary for efficient production of nitrogen by the legume.

Reduced Leaching of Potassium

On the soil's exchange complex there are a limited number of sites that can hold nutrients such as potassium. If these sites are strongly occupied by aluminum, the condition found with a low soil pH, then any potassium added as fertilizers is more subject to leaching. Proper liming will not completely reduce leaching but will tend to minimize it, particularly on sandy surface soils.

Increased Available Molybdenum

Molybdenum is an essential micronutrient for nodule production by the legumes that are used in turf. Proper liming will increase the soil pH and in turn make the soil's molybdenum resources available for use by the plants. Although molybdenum is used in a very small quantity, a low soil pH might prevent an adequate level from being available for the turf legumes.

Influence on Herbicides

Proper liming will help improve the performance of selected herbicides. Examples of this would be improved performance of Atrazine or Simazine. There are, on the other hand, many herbicides that are not influenced by soil pH.

All of the above-mentioned benefits will improve growth and uniformity of cover on any established turf. Furthermore, lime will enhance the control of weedy species through improved competition of turf and a more vigorous healthier plant that will perhaps tolerate disease or insect infestations.

Fineness of Limestone

When a given quantity of crushed limestone is thoroughly incorporated within the soil, its reaction or the rate at which it changes soil pH depends upon the size of the individual particles. If they are coarse the reaction or change in soil pH will be small, but if they are fine the reaction will be quite rapid and extensive. This is illustrated in the enclosed figure. You will note that with the passage of time the finer materials cause a very significant increase in pH whereas those materials from 4 to 8 mesh or coarser had very little effect on soil pH. For all practical purposes the 4 to 8 and 8 to 20 mesh were of little effect over this 18-month period of the experiment. The 40 to 50 mesh material, as

well as the 80 to 100 mesh, caused an increase in pH of a marked degree even as early as six months and this effect appears to continue through 18 months. The response to the 100 mesh material was quite rapid and would be more nearly equal to that expected from the application of calcium oxide (burned lime) or calcium hydroxide (slaked lime). Both products will be described later on. These kind of data are the basis for minimum screen sizes that are established by the N. C. Department of Agriculture in order for liming materials to be called ag lime.

It is further realized that the cost of limestone increases with the fineness of grind. What is needed is a material that requires a minimum of grinding, yet contains enough fine material to bring about a pH change rapidly. As a result, agricultural limestone contains both coarse and fine materials. Many states require that 75 to 100 percent of the limestone pass an 8 to 10 mesh screen and that 20 to 80 percent pass anywhere from an 8 to 100 mesh screen. In this way there is a fairly good distribution of both the coarse and fine particles.

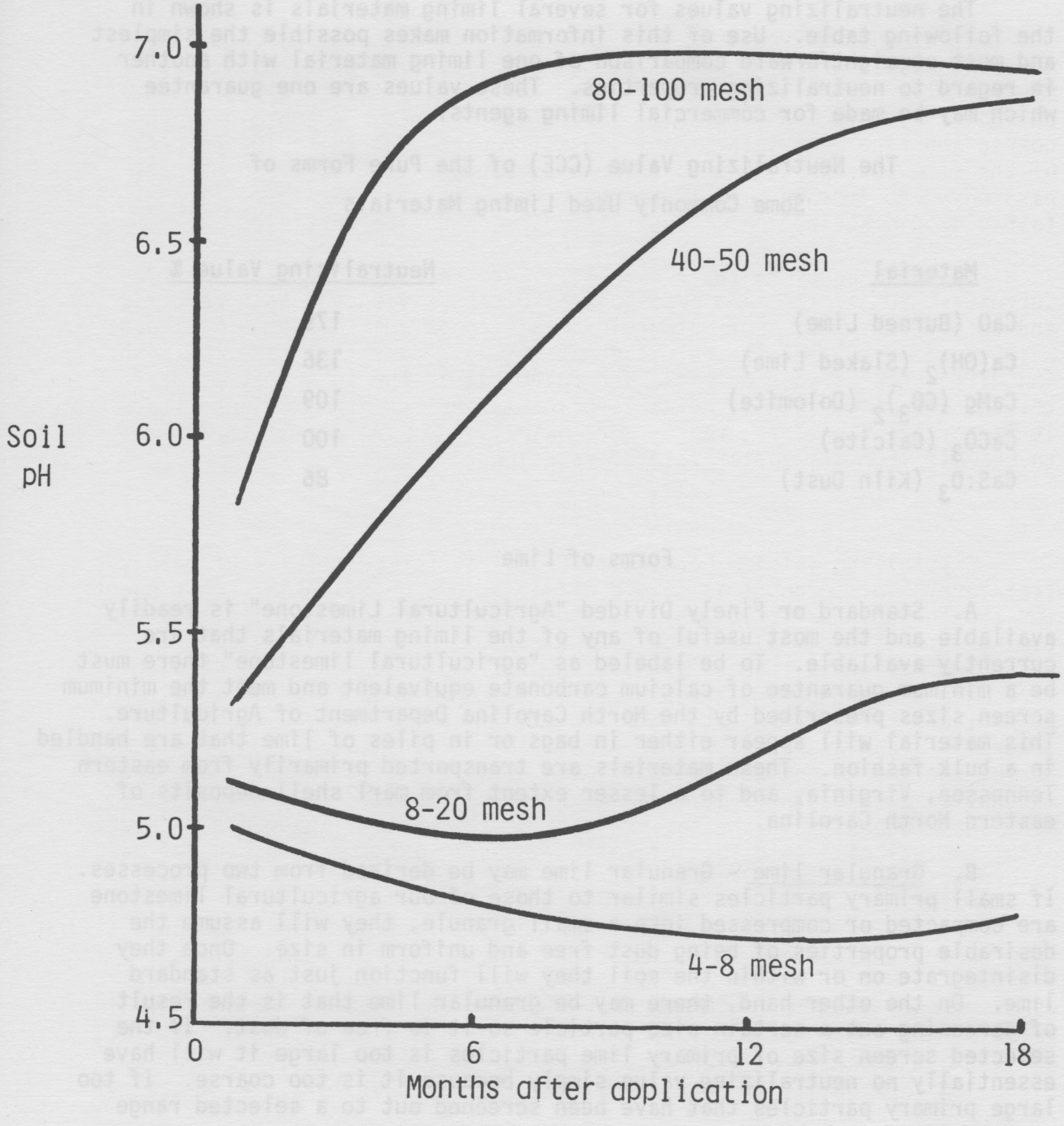
In North Carolina two screen sizes are required for minimum sizes. Currently, 90% of the lime must pass a 20-mesh screen for both calcitic and dolomitic types. Furthermore, 35% of the dolomitic source must pass a 100 mesh and 25% of the calcitic sources must pass that same 100 mesh. The difference between calcitic and dolomitic is the fact that much of the calcitic lime sold in North Carolina is derived from marl shell and it is softer; therefore, reacts more quickly and will permit the user to benefit from its faster rate of reaction.

Types of Lime

Crystalline calcium carbonate ($CaCO_3$) is termed calcite or calcitic limestone. This product is devoid of magnesium, an essential constituent for the formation of chlorophyll of leaves. A second general category of liming material is that derived from a mixture of crystalline calcium-magnesium carbonate [$CaMg(CO_3)_2$] is known as dolomite when the calcium carbonate and magnesium carbonate occur in equal proportions. In other proportions they are said to be dolomitic limestone. Deposits of high grade limestone are quite widespread in the United States. Unfortunately, North Carolina is not blessed with much dolomitic limestone. There are, though, some deposits of soft non-crystalline calcitic lime derived from marl shell deposits in the eastern part of the state. These are uncovered after removal of 4 to 8 foot of soil overburden and then crushed and dried before being distributed to the user.

The quality of limestones either derived from marl shell or crystalline form depends on the degree of impurities they contain; such as, clay, organic matter, or very fine silt and/or sand. The neutralizing values usually range from 65 to 70% to a little more than 100%. The neutralizing value of chemically pure calcium carbonate has been established arbitrarily at 100% and theoretically chemical pure dolomite (mixture of calcium and magnesium carbonate) may have a neutralizing value of 109%. As a general

Dolomitic Lime - Effect of particle size
on soil pH with passage of time
- Canfield Silt Loam -



rule, however, the neutralizing value or calcium carbonate equivalent of most agricultural limestones is between 90 and 98% because of its impurities. The marl deposits of eastern North Carolina are approximately 80 to 85% calcium carbonate equivalent.

The neutralizing values for several liming materials is shown in the following table. Use of this information makes possible the simplest and most straightforward comparison of one liming material with another in regard to neutralizing properties. These values are one guarantee which may be made for commercial liming agents.

The Neutralizing Value (CCE) of the Pure Forms of Some Commonly Used Liming Materials

Material	Neutralizing Value %
CaO (Burned Lime)	179
$Ca(OH)_2$ (Slaked Lime)	136
$CaMg(CO_3)_2$ (Dolomite)	109
$CaCO_3$ (Calcite)	100
$CaS:O_3$ (Kiln Dust)	86

Forms of Lime

A. Standard or Finely Divided "Agricultural Limestone" is readily available and the most useful of any of the liming materials that are currently available. To be labeled as "agricultural limestone" there must be a minimum guarantee of calcium carbonate equivalent and meet the minimum screen sizes prescribed by the North Carolina Department of Agriculture. This material will appear either in bags or in piles of lime that are handled in a bulk fashion. These materials are transported primarily from eastern Tennessee, Virginia, and to a lesser extent from marl shell deposits of eastern North Carolina.

B. Granular lime - Granular lime may be derived from two processes. If small primary particles similar to those of our agricultural limestone are compacted or compressed into a small granule, they will assume the desirable properties of being dust free and uniform in size. Once they disintegrate on or within the soil they will function just as standard lime. On the other hand, there may be granular lime that is the result of screening out a certain size particle so it is free of dust. If the selected screen size of primary lime particles is too large it will have essentially no neutralizing value simply because it is too coarse. If too large primary particles that have been screened out to a selected range

of sizes, the product will be very disappointing and money will be wasted applying this material. One might just as well use similar sized sand particles. A practical way of determining the difference is to simply take the product and crush it between your fingers or between a couple of pieces of wooden block to see if the granules will further breakdown.

C. Suspensions of Limestone - This is a relatively new process whereby standard agricultural lime is suspended with the use of kaolinitic clay to make a fluid material that can be uniformly spread on the soil surface. The problem of dust is eliminated. On the other hand, equipment for spraying this product must be similar to that that will apply fertilizer suspension fertilizer. It can be spread uniformly on the surface and relatively small amounts can be put out uniformly. There are some reports of this material changing soil pH very rapidly. This is so only because the particles that are suspended have been ground very finely. Approximately one-half of the weight of the product is water. Therefore, for example, 1,000 pounds of a suspension may contain only approximately 500 lbs. of liming material. Research has indicated that the value of suspensions must be considered on the basis of the lime content, the same as dry, standard agricultural limestone is considered.

D. Calcium Oxide - This product is also known as unslaked lime, burned lime, or quick lime (CaO). It is a white powder quite disagreeable to handle. It is manufactured by roasting calcitic limestone in an oven or furnance. The carbon dioxide is driven off leaving calcium oxide. The purity of the burned lime depends on the purity of the raw material. This product is shipped in paper bags because of its very fine powdery nature and its caustic properties. When added to the soil it reacts almost immediately. When unusually rapid results are required, either this material or calcium hydroxide (to be discussed later) should be selected. Complete mixing of calcium oxide with the soil may be difficult, however, for immediately after application absorbed water causes the material to form flakes or granules. These granules may harden because of the formation on their surfaces of calcium carbonate and in this condition they may remain in the soil for long periods of time. Only by very thorough mixing with the soil at application time can this caking be prevented. On a pound for pound basis calcium oxide is the most effective of all the liming materials commonly employed for the pure material has a neutralizing value or calcium carbonate equivalent of 179% compared with pure calcium carbonate.

E. Calcium Hydroxide - $Ca(OH)_2$ is frequently referred to as slaked lime, hydrated lime, or builders lime. Like calcium oxide it is white, powdery substance, difficult and unpleasant to handle. Neutralization is rapidly achieved as it is with calcium oxide. Slaked lime is prepared by hydrating calcium oxide, that is, adding water to it. Much heat is generated and on completion of the reaction the material is dried and packed in paper bags. The purity of the commercial product varies but the chemically pure compound has a neutralizing value of 136 making it pound for pound the second most efficient--only behind calcium oxide--commonly used liming material.

F. By-Products

I. Lime Sludge - Usually where craft paper is manufactured there will be a by-product, lime sludge, from the paper manufacturing process. An important example of this is at Canton, N. C. where Champion Paper Company has large quantities of a wet sludge material that is derived from the use of calcitic lime. This product has approximately 38% water when discharged from the plant. It can be deposited and permitted to dry through evaporation and stirring by mechanical equipment. It has a high calcium carbonate equivalent (averages 95%) and could find some value on turf if it can be handled satisfactorily after drying some of the water which it contains. Efforts are underway in the Canton area to make it available in a satisfactory fashion for use by forage producers of that area.

II. Kiln Dust - This is stack dust that comes from the manufacture of cement. There is considerable variation in its liming value. Traditionally it has been used as a potassium fertilizer, but may have considerable liming value. Currently, there are considerable quantities of kiln dust being returned to a landfill at Castle Hayne, N. C. by Ideal Cement Company. It has 80 to 85% calcium carbonate equivalent. There has been interest in its use as a lime suspension. If this product is incorporated in a suspension, there will be very minimal problems in the dust associated with its distribution on fields when it tends to dry out.

III. Fly Ash - Fly ash is a fine product trapped by electrostatic precipitators as pulverized coal is burned in an electric power generating stations. Most of it is currently disposed of in land fills. Because of its high variability, its elemental content would need to be carefully tested or monitored. It could be a liming material. On the other hand, there may be off-setting characteristics such as arsenic and boron which may be toxic to sensitive plants and possibly some heavy metals.

IV. Slags - Several types of liming materials classed as slags could be important liming materials. They are first blast furnance slag that behaves essentially as a calcium silicate. The neutralizing value of blast furnance slag varies from 75 to 90%. It usually contains an appreciable amount of magnesium. If they are applied on the basis of equivalent amounts of calcium and magnesium, they could be just as effective as ground limestone in producing crops. Secondly, basic slag contains not only a calcium silicate with approximately 60 to 70% calcium carbonate equivalent, but is a source of phosphorus, Thirdly, electric furnance slag would contain a small amount of phosphorus and have a neutralizing value of 60 to 80%. Its reaction with the soil is similar to that for blast furnance slag. All of these materials might be utilized locally. They are sold to a very limited extent in North Carolina.

V. Recent reports indicate that there is a liming material that is a by-product of the fertilizer industry near Tunnis, N. C. This is a very finely ground material that has a 80% calcium carbonate equivalent. It is somewhat high in moisture and is characterized as having many large soft granules of material. It is somewhat hard to spread and might be undesirable for people walking across turf to which this has been applied.

VI. Occasionally there are some industrial cleaning agents such as caustic (NaOH) or potassium hydroxide (KOH) that would have some liming value. Again, one would need to monitor the nutrient content with analytical tests to determine not only the constituents but its calcium carbonate equivalent. These may be important locally if they are possible to handle in a practical way.

Products of Questionable Value

Over the past 10 or 15 years there has been some liquid materials purported to have "miracle liming properties". These are dilute solutions of calcium hydroxide and weak organic acids. They have very limited value. They have been sold under the names of "Liqui-Lime," "Promosol-30" or "Grow-Green." An evaluation of these products by several experiment station workers the past several years has shown them to be of very limited value.

A DAY IN AGRICHEMICAL RESEARCH

HARRY H. HARDER
E. I. DU PONT DE NEMOURS & CO.
BIOCHEMICALS DEPARTMENT
CARY, NORTH CAROLINA

This film focuses on scientists' activities in the laboratory and field testing of new candidate plant protectants. Four to six years in tests for efficacy, chronic toxicology (two to four year feeding studies, pathology reports), metabolism and residue, (water, plant, animal), bioefficacy confirmation (experimental registration, application for full registration), analysis for chemical antilogs, patent coverage, process engineering (process development, data reports, site preparation), ultimate manufacturing of an agrichemical.

In most cases ten to fifteen thousand compounds must be synthesized before one material meets all the criteria of a marketable product. Costs are continuing to rise, and it is estimated by 1983 a new compound could cost upwards of $25 million before the first pound or gallon is sold commercially. Even with these very high costs, the Du Pont Company is committed to the agrichemical markets and will continue to produce active, high quality plant protectants.

PESTICIDE DISSIPATION IN THE ENVIRONMENT

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When toxic organic chemicals such as pesticides are used in the environment, it is important to know what happens to them. These substances like all organic molecules are subjected to many different processes which tend to degrade the chemicals and move and mix them into the soil, water and air. Whether a given chemical is degraded depends upon the properties and accessibility of the chemical. Some of the older pesticides like DDT and other highly halogenated compounds were very resistant to both biological and chemical decomposition (Table 1). Hence, these materials were said to be persistent. Because of their very low water solubility and high lipophilic character, chemicals such as DDT and PCB also tended to biomagnify in the fatty tissues of many wildlife species. It was for this reason that these chemicals were removed from the market and replaced by chemicals which decompose in a relatively short time and which do not biomagnify in wildlife.

Processes Involved

Once a pesticide has been applied to turf, various processes immediately begin acting on it. Some of these processes actually tear the pesticide molecules apart. Others merely serve to transfer the pesticide molecules from one place to another.

The various processes and factors involved in the dissipation of pesticides in the environment are shown in Figure 1. In nature, degradation and transfer processes play a role in the ultimate fate of a pesticide in the environment. The degradation processes include biological, chemical, and photochemical decomposition, and are shown in the figure as processes whereby the pesticide (PS) molecule is split apart.

The transfer processes include absorption, retention, accumulation, and exudation (excretion by organisms), adsorption by soil colloids and other surfaces, and movement in the vapor, liquid, and solid states through the atmosphere, soil, and water. In Figure 1, transfer processes are shown as those in which the pesticide (PS) molecules remain intact.

Innumerable different kinds of measurements and tests are required to better understand the fate, behavior, and ultimate safety of a pesticide in the environment. Measurements of the chemical, biological, and edaphic properties, and the methods of application of particular pesticide are needed. Examples of the dissipation of herbicides in the environment will be discussed but the principles are applicable to all pesticides.

Biological Decomposition

Biological decomposition of pesticides includes detoxification by plants and soil organisms. This breakdown process involves several mechanisms.

Pesticides may be absorbed by plants and microorganisms and stored or given off (exuded) in their original form. Usually they are changed, however, and the breakdown products are either used by the organism or discharged into the environment. 2,4-D is a turf herbicide that is readily degraded by soil microorganisms (Table 1). Mecoprop, dicamba, and metribuzin are degraded much more slowly than 2,4-D. The remaining chemicals take considerably longer to decompose.

Chemical Decomposition

Several types of reactions account for the chemical decomposition of herbicides:

1. Oxidation is a decomposition reaction in which a compound loses electrons, as in the case of the oxidation of 2,4-D and mecoprop.

2. Reduction is a reaction opposite to that of oxidation. In reduction, a herbicide gains electrons, as in the case of degradation of benefin.

3. Hydrolysis is a degradation process by which water in a strongly acid or strongly basic environment reacts with a herbicide to form a different compound. DCPA and metribuzin are hydrolyzed in soils and the rate of degradation depends on many factors including soil pH, temperature and moisture.

The decomposition products are normally nontoxic substances that are similar to organic molecules present in soils and plants.

Photodecomposition

A herbicide applied to plant foliage or the soil surface is subject to decomposition by action of sunlight. Most organic herbicides are susceptible to a certain amount of photodecomposition but some are degraded more than others. Some photodegradable turf herbicides would include 2,4-D and benefin. Herbicides which are relatively resistant to photodecomposition are CMA, MAMA, DSMA, MSMA, siduron, DCPA and paraquat.

Water soluble herbicides are carried into the soil by rainwater, and this reduces their decomposition by sunlight. Once a herbicide has been washed down into the turf or soil, its chances of being photodecomposed are slight.

Adsorption

All herbicides are bound to soil particles to some extent. Positively charged chemicals, like paraquat, are strongly adsorbed by negatively charged soil colloids, such as organic matter and clay minerals, in a manner similar to the retention of nutrient ions, like potassium and calcium. Such chemicals are essentially immobile in soils (Table 2).

Negatively charged acid herbicides like dicamba, 2,4-D, mecoprop and bentazon are not readily adsorbed by soil colloids and hence, like nitrate and chloride ions, tend to be very mobile in soils. These chemicals are easily leached. Their movement in soils is related to the soil texture. They leach more readily in coarse-textured soils such as the sands, than in the fine-textured soils such as the clays or the organic soils.

Negatively charged arsenate herbicides such as CMA, MAMA, DSMA and MSMA, are strongly adsorbed to positively charged hydrous oxides and clay minerals in a manner analagous to the fixation of phosphate ions by these soil colloids. These chemicals are thus relatively immobile in soils.

Uncharged, relatively water-soluble herbicides such as metribuzin are only weakly adsorbed to soil colloids and thus are relatively mobile. At very low pH levels, however, metribuzin becomes cationic and is strongly adsorbed and is not very mobile in soil. Uncharged herbicides of lower water solubility, such as siduron and pronamide, are much less mobile than metribuzin. Oxadiazon, DCPA, and benefin are also uncharged herbicides, but their water solubilities are so low that the chemicals are practically immobile in soils.

The adsorption process greatly affects the absorption rate of herbicides by plants and other organisms. Thus, it determines herbicide performance and persistence. Losses of volatile herbicides, such as benefin, from soils are greatly affected by adsorption processes. Adsorption also has a lot to do with how herbicides move in the soil solution.

Volatilization

Herbicides, such as metribuzin, dicamba, 2,4-D, mecoprop, pronamide, and benefin, that have evaporated (undergone volatilization) are present as gases in the atmosphere, where the sun may break them down. Soil texture, temperature and moisture content affect volatilization. Losses generally decrease as the size of the soil particles decrease. Thus, there is faster vaporization on coarse-textured than on fine-textured soils. Higher soil temperatures and moisture contents also speed up herbicide volatilization. There is less loss when volatile herbicides are applied to cool, relatively dry soils than when they are applied to hot, wet soils.

Herbicide Runoff

Herbicides applied to turf may dissolve in rain or sprinkler water and be leached into the soil, depending on their chemical properties and the soil type (Table 2). Or, heavy applications of water may carry them away from treated areas. Severe runoff can also carry soil particles with adsorbed herbicides off with eroding soil and water. "Washoff" is the term used to describe such losses. Herbicides washed into ponds may affect aquatic vegetation, but rarely do they affect fish or other aquatic animals. Herbicides are generally very low in toxicity to organisms other than plant life. This is not the case with certain insecticides, however.

All Processes Related

All processes involved in pesticide degradation and transfer are intimately associated. Adsorption, which directly influences all others, is probably the key process.

The transfer processes are usually reversible and in dynamic equilibrium with the system. Cationic herbicides, like paraquat, are exceptions since they are irreversibly adsorbed between the crystalline sheets of certain clay minerals. The molecules are held so tightly that they are neither degraded nor released from the clay particles. Other pesticides are adsorbed in a reversible equilibrium state and are subject to breaking down in soil systems. Recent evidence, however, shows that some pesticides react slowly with certain soil colloids and are released for utilization by plants or degradation by microorganisms at a very slow rate.

Except for gross misapplications and overuse, the degradation processes described will break pesticides down into safe or nontoxic compounds. There is little evidence of potential buildup or persistance in the soil to contaminate the environment.

Disposal of Unused Pesticides and Containers

Pesticides should never be left in the sprayer when a job is completed. They should be sprayed out on the crop to which they were being applied over an area such that no more than a total of a 2X rate is applied in any one place. The spray tank and sprayer should be rinsed with water and sprayed on the crop in a similar manner.

Old pesticides or the remains from spray tanks may be disposed of in an evaporative pit constructed according to the following Environmental Protection Agency procedures.

An effective reinforced concrete pesticide evaporative disposal pit may be constructed with the following dimensions: The inside pit dimensions are 3.35 m (width) x 8.84 m (length) x 1 m (depth). It is filled with soil and gravel layers each approximately 30 cm thick. A motorized cover triggered by rainfall closes to prevent flooding should be installed.

Aerobic bacterial activity in the soil is highly effective in biodegrading most of the commonly used pesticides. Liquids continue to evaporate with no detectable atmospheric pollution. Approximately 6000 gallons of water will evaporate from this pit in one season. The pit must not be subjected to leakage as resistant chemicals such as atrazine, alachlor, and trifluralin are relatively resistant to decay and take more time to decompose than the phenoxy, organophosphorous or carbamate chemicals.

Pesticide containers should be disposed of in the following manner:

Metal containers: Triple rinse with water and dispose of at a metal recycling plant or in a sanitary landfill.

Plastic containers: Triple rinse and dispose of by incineration or in a sanitary landfill.

Glass containers: Triple rinse and dispose of in a sanitary landfill.

Paper containers: Incinerate or dispose of in a sanitary landfill.

Table 1. Organic chemicals which persist in the environment.

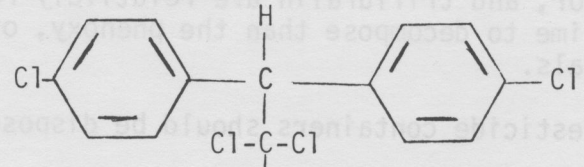
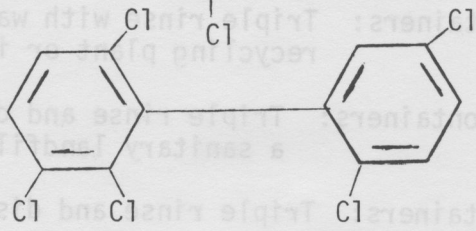
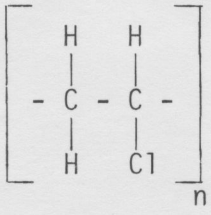
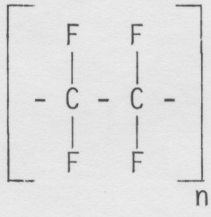
Name	Use	Molecular Structure
DDT	Insecticide	
PCB	Transformer fluid	
Polyvinyl chloride	Plastic film	 ..... n = about 1000
Teflon	Nonstick surfaces	 ..... n = about 1000

Table 2. Properties of herbicides commonly used in turf.

Common name	Molecular charge	Water solubility (ppm)	Adsorption to soil	Mobility in soil	Volatility	Longevity (wks)
Paraquat	Cationic	100%	Very high	Very low	Very low	Long, but low bioactivity in soil
Metribuzin	Nonionic and cationic	1220	Moderate to high	High to moderate	Moderate	4-8
Dicamba (acid or salt)	Anionic	4500	Very low	Very high	Moderate	3-6
2,4-D (acid or salt)	Anionic	900	Very low	Very high	Moderate	1-4
Mecoprop (acid or salt)	Anionic	620	Very low	Very high	Moderate	3-4
Bentazon	Anionic	500	Moderate	Moderate	Very low	3-6
Bensulide	Anionic	25	High	Low	Very low	32-48
CMA	As anion	50%+	High	Low	Very low	Long, but low bioactivity in soil
DSMA	As anion	50%+	High	Low	Very low	Long, but low bioactivity in soil
MAMA	As anion	50%+	High	Low	Very low	Long, but low bioactivity in soil
MSMA	As anion	50%+	High	Low	Very low	Long, but low bioactivity in soil

Table 2 (continued)

Common name	Molecular charge	Water solubility (ppm)	Adsorption to soil	Mobility in soil	Volatility	Longevity (wks)
Siduron	Nonionic	18	High	Low	Very low	Long, but low bioactivity in soil
Pronamide	Nonionic	15	High	Low	Moderate	8-36
Oxadiazon	Nonionic	0.7	Very high	Very low	Very low	
DCPA	Nonionic	0.5	Very high	Very low	Very low	10-12
Benefin	Nonionic	0.2	Very high	Very low	Moderate	16-20

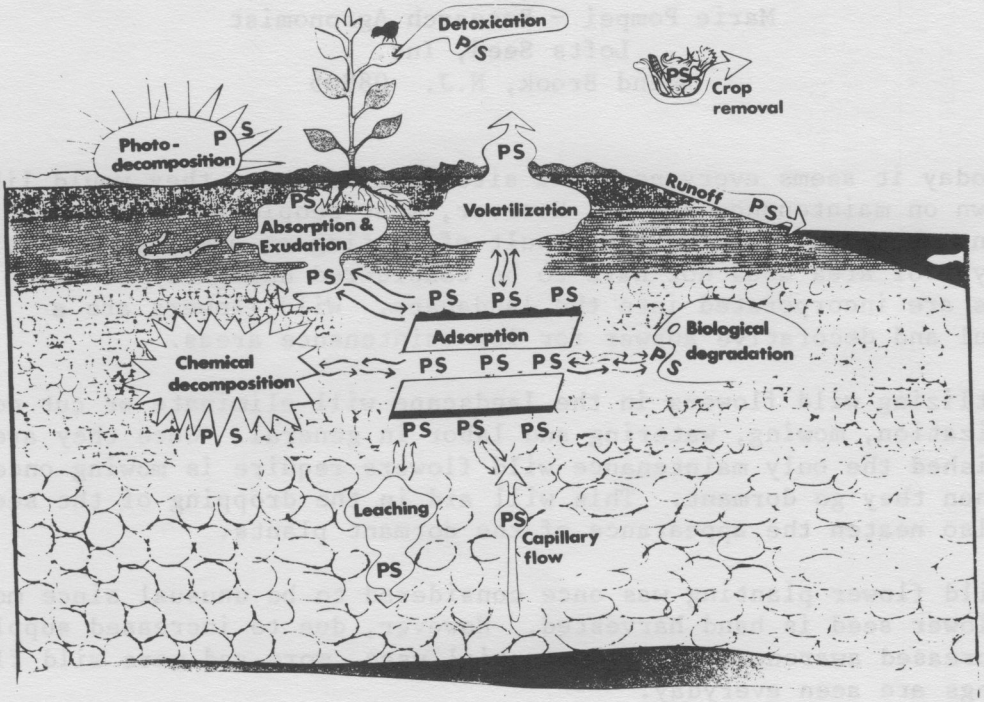


Figure 1. Dissipation of pesticides in the environment. Degradation processes are characterized by the splitting of the pesticide molecule. Transfer processes are characterized by the molecules remaining intact.

THE UTILIZATION OF WILD FLOWERS IN TURF AREAS

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Today it seems everyone has a site in mind where they would like to cut down on maintenance costs. However, most people are a little hesitant when they imagine the result of letting an area "go natural." This type of area does not have to be considered unsightly if wild flowers are incorporated into the landscape. Wild flowers are a colorful and decorative answer for low maintenance areas.

Utlizing wild flowers in the landscape will eliminate or cut down on fertilization, mowing, watering and labor in general. Once they are established the only maintenance wild flowers require is mowing once a year when they go dormant. This will aid in the dropping of the seed and will also neaten the appearance of the dormant plants.

Wild flower planting was once considered to be unusual since most wild flower seed is hand harvested. However, due to increased supplies and increased awareness of its potential uses, more and more wild flower plantings are seen everyday.

Loft's Seed has been marketing the Pinto Wild Flower Seed mixtures successfully for a half dozen years. We have noticed the great increase in demand during this time and believe that this demand reflects a desire of turf managers everywhere to cut down on maintenance costs.

Wild flowers can be incorporated into any type of landscape, whether it be parks, roadsides, golf course roughs, industrial and landfill sites. The idea of an attractive, low maintenance wild flower mix is very appealing to golf course superintendents who would like to cut down on maintenance costs but still keep their course looking top-notch. Wild flowers can be used in golf course roughs, islands, in ponds and lakes, slopes and any hard to maintain areas.

Lofts now markets four different wild flower mixtures - Northern, Southern, Canadian and Texarkana. Either the Northern or Southern mix would be adaptable to North Carolina, depending on the exact location.

Each Pinto Mixture was specifically designed to be an adaptable, hardy mixture with species that would easily germinate and grow under a wide variety of growing conditions, whether it be poor soil, dry or wet conditions. Each mix has the advantage of including at least ten species. If one specie is less adapted at a specific site there are other wild flowers that will be. Plant color, height, attractiveness and seed availability were also important considerations in designing the mixtures. Popular species such as Lance Leaved Coreopsis, Scarlet Flax, Bachelor's Button, Black-Eyed Susan and Painted Daisy are included.

The Pinto mixtures include both perennials and annuals. The perennials will, of course, come back and flower the following year. All of the annuals included in the mixtures are heavy reseeders and will grow and flower the first year. produce seed, and then germinate and flower the following year.

All of the mixtures were designed to include wild flowers that will germinate within fourteen days if there is sufficient moisture available. Once established some species will bloom in six to eight weeks after planting. Others require various degrees of maturity before they will flower. There is a succession of flowering during the growing season which gives a very natural effect.

Planting wild flower seeds is relatively easy. On bare soil areas first rake the area to form grooves so that the seed has good soil contact. The seed can then be sown using a drop spreader or cyclone spreader. When using low seeding rates, coverage can be improved by adding sand, Milorganite or a noncompetitive grass to the wild flower seed to bulk up the mix. Once seeded, lightly rake over the area to ensure proper soil seed contact.

In areas with existing grass use Roundup to eliminate any grass or weed cover and then scarify the area with a rank or tine harrow to expose the soil surface. The seed can then be sown using the same methods mentioned above. A vertical groove seeder (Rodgers 548) may also be used which scarifies and seeds at the same time. The final step would be a light raking.

Planting dates depend on site location. Best results are obtained from early spring plantings when the weather breaks. For late summer plantings, schedule seeding at least eight to nine weeks before the first expected frost.

Applying fertilizer at the time of seeding is not necessasry in establishing wild flowers. Since fertilizers encourage weed growth, they should only be used on wild flowers if soil conditions are extremely sterile. If a fertilizer is to be used, a 5-10-10 or similar ratio is advised.

The Pinto mixtures can be used on moderately sloped sites when sheep fescue or a low rate of tall fescue is included. Soil stabilization would be increased on unstable sites if the wild flower seeding rate is tripled.

Utilizing wild flowers in the landscape may not be an instant solution to every problem site, but it certainly is an option worth considering. When used properly, wild flower plantings are the option that will save turf managers time and money. This fact should be of interest to anyone involved in grounds maintenance.

PESTICIDE LAWS AND REGULATIONS

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North Carolina has been involved in a formal pesticide education program since 1973. The State certifies farmers who use restricted use pesticides in a four (4) hour training program. It conducts two day training schools and licenses dealers that sell restricted use pesticides to the end user and commercial applicators, public operators and consultants who apply or give advice on any pesticide. By December 31, 1981 over 50,000 farmers, 3,000 dealers and 7,000 commercial applicators and public operators had been trained by the North Carolina Agricultural Extension Service. As of May 1, 1981 active licenses and/or certifications were held by 50,703 farmers, 1,720 dealers, 1,645 ground commercial applicators, 176 aerial applicators, 1,254 public operators, 29 consultants and 725 structural pest control operators.

Since January 1, 1981 North Carolina has been involved in a recertification program for commercial applicators, public operators and consultants. The program offers licensees three recertification options (1) continuing certification credits for training in pesticide related subjects, (2) review sessions and re-test or (3) a re-test. Ground applicators, depending on their specialty, need 3-10 hours of credits under option one during a five year period to qualify for a license the sixth year. Aerial applicators must obtain 4 hours of training during a two year period to qualify for licensing the third year. For additional specialties, ground applicators must have three additional hours of training during a five year period. The aerial applicator needs one hour of credit for each additional specialty category during a two year period.

North Carolina applicators and consultants can obtain recertification credits at various training opportunities across the State that have been approved by the North Carolina Pesticide Board. Courses must be recommended to the Board by a Pesticide Recertification Credit Committee. A program leader for each of the specialty categories (Agricultural Pest-Plant, Ornamentals-Turf, Forestry, etc.) coordinates recertification efforts in each of the disciplines. Licensees attending recertification credit training sessions must enter their name and social security or pesticide license number on a roster at each training session. The North Carolina Department of Agriculture (Pesticide Section) keep records on recertification credits and notifies licensees of their current recertification status.

The Pesticide Board has approved five hours of training during a five year period for pesticide dealers but the starting date for recertification has not been set. Farmers (private pesticide applicators) are not yet under a required recertification program in North Carolina.

WINTER OVERSEEDING

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Each fall thousands of acres of warm season turf are overseeded with cool season grasses in order to provide a functional and aesthetic winter turf. Winter overseeding is practiced on home lawns, industrial grounds, athletic fields, roadsides, and golf courses. The presence of overseeded turf during the winter months provides an appealing vista, a functional playing surface to withstand wear and traffic, and extends the open season for athletic fields and golf courses. However, it is important to remember that the overseeded turf will compete with the underlying warm season turf for nutrients, light, and water, particularly during the spring and fall.

The development of the improved perennial ryegrasses have done much in the way of increasing the quality of overseeded turfs. These grasses germinate rapidly, are fine textured, have a good green color, and improved disease and traffic resistance. Mixtures of the improved perennial ryegrasses with chewings fescue, Kentucky bluegrass, and/or rough bluegrass are generally preferred over blends of ryegrasses alone. Mixtures offer a broader genetic base for resistance to pests, particularly disease. The inclusion of rough bluegrass (Poa trivialis) has increased the quality of the overseeded turf during the late winter and early spring. Bentgrasses have been included for overseeding purposes from time to time, but are generally unsatisfactory when utilized in this manner.

The performance of overseeded turf will fluctuate through the dormant period of the warm season grasses. Figure 1 shows how the quality of overseeded turf typically varies through the year. Initially quality of the warm season turfs is reduced during preparations for overseeding (dashed line). Once germination and establishment of the overseeded grasses has occurred, turfgrass quality improves. Turf quality will remain high until December when low temperatures restrict the growth and recovery of the turf. The return of warmer weather in late February allows for renewed growth of the turf and a subsequent improvement in the quality of the overseeded turf.

Preparations for overseeding must begin prior to the date that seed is broadcast into the warm season turf. This is particularly true in the case of fine turf areas such as golf greens. Overseeding should take place a minimum of 20 days before the first date of expected frost. In Raleigh, overseeding is typically done between September 15 and October 7. Overseeding should be done about one to two weeks earlier for those regions west of Raleigh, and one to two weeks later for those regions to the east.

Warm season turfs which will be overseeded should be soil cored (aerated) three to four weeks prior to overseeding in order to alleviate soil compaction, and open the turf to help ensure subsequent seed-soil contact. It is important that soil coring holes heal over prior to overseeding. If these holes do not heal over, the germination and growth of the overseeded turf will not be uniform. Reduce the cutting height, verticut the turf in at least two directions, and water thoroughly three to four days prior to overseeding. Seed the turf in two to three directions at the recommended rate of application. Golf greens are typically seeded at a rate of 30 to 40 pounds per 1000 sq. ft. If Poa trivialis is contained in the mix, the seeding rate should be reduced to 20 pounds per 1000 sq. ft. Fairways are typically seeded at 5 pounds per 1000 sq. ft. Home lawns, tees, and other areas can be seeded at 3 to 15 pounds per 1000 sq. ft. depending on the desired density and overall quality of the overseeded turf.

Once broadcast, the seed should be matted into the soil surface. A rug or old carpet section with a light board on top works well. Topdressing after seeding is essential if proper seed-soil contact and subsequent germination is to occur. However, topdressing is often too time consuming and expensive to be conducted when overseeding lower maintenance areas such as fairways and home lawns. Topdress with a proper mix at a rate of about 0.4 cubic yards per 1000 sq. ft. Newly overseeded turfs will require watering two to three times daily at first. Irrigation frequency must be reduced after germination has occurred and the cool season turf requires clipping. Use only sharp blades when initially mowing overseeded turfs.

Spring transition from the overseeded turf back to the warm season grasses requires as much effort as the fall overseeding process itself. New growth of warm season turfs is often first noticeable along paved walkways and along buildings or other similar areas. Cultural practices which will favor the growth of the warm season turf over that of the cool season should begin two to three weeks after new warm season growth is first observed in these areas. While the exact timing of such cultural practices must be balanced against the scheduled use of the turf, the removal of the overseeded turf must be culturally enhanced in the spring. Cultural practices which will enhance the removal of the overseeded grasses include infrequent but thorough irrigation, reduced cutting height, soil coring, and verticutting.

NCSU OVERSEEDING EVALUATIONS

Temperature departures from normal as recorded at NCSU for overseeding seasons 1979-1980 and 1980-1981 are shown in Figure 2. Fall 1979 temperatures were initially below normal, but then climbed to above normal through mid-December. The incrased temperatures of fall 1979 did

much in improving the performance of overseeded turf during 1979-1980. Germination of overseeded turf was impaired during the fall of 1980 by both temperature extremes and insufficient rainfall. The average temperature dropped from much above normal in September to over 2° F below normal for October and November (Table 1).

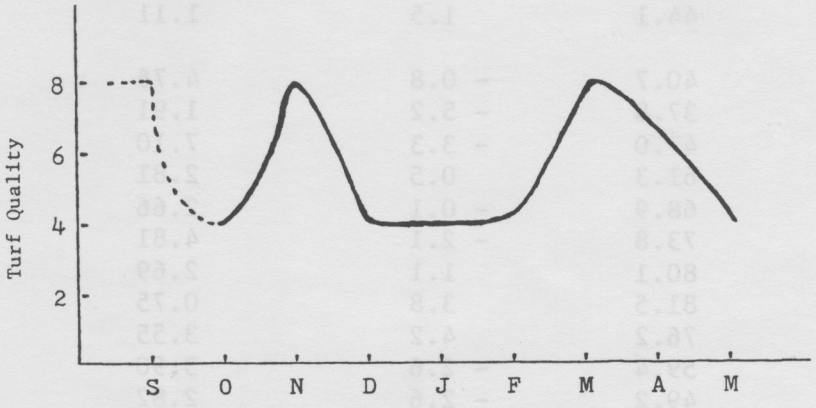

Figure 1. Generalized winter overseeding's performance.

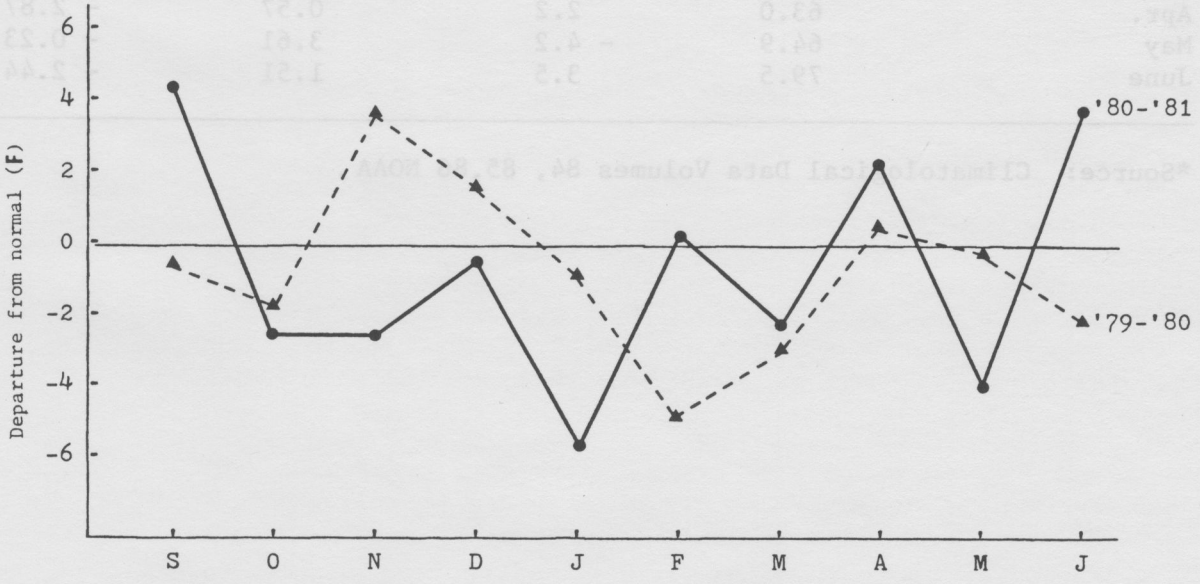

Figure 2. Temperature (F) departures from normal recorded at NCSU from September 1979 through June 1981.

Table 1. Temperature and precipitation recorded* at North Carolina State University for the period September 1979 through June 1981.

Date	Mean Temperature (°F)	Departure From Normal (°F)	Mean Precipitation (inches	Departure From Normal (inches)
Sept. 1979	71.5	- 0.5	8.13	3.80
Oct.	60.2	- 1.8	2.38	- 0.57
Nov.	55.6	3.8	6.35	3.21
Dec.	44.1	1.5	1.11	- 2.05
Jan. 1980	40.7	- 0.8	4.76	1.47
Feb.	37.8	- 5.2	1.91	- 1.60
Mar.	47.0	- 3.3	7.10	3.35
Apr.	61.3	0.5	2.81	- 0.63
May	68.9	- 0.1	2.66	- 1.18
June	73.8	- 2.1	4.81	0.86
July	80.1	1.1	2.69	- 2.99
Aug	81.5	3.8	0.75	- 4.12
Sept.	76.2	4.2	3.55	- 0.78
Oct.	59.4	- 2.6	3.90	0.95
Nov.	49.2	- 2.6	2.82	- 0.32
Dec.	42.2	- 0.4	2.45	- 0.71
Jan. 1981	35.6	- 5.9	1.29	- 2.00
Feb.	43.3	0.3	3.39	- 0.12
Mar.	48.1	- 2.2	2.41	- 1.34
Apr.	63.0	2.2	0.57	- 2.87
May	64.9	- 4.2	3.61	- 0.23
June	79.5	3.5	1.51	- 2.44

*Source: Climatological Data Volumes 84, 85,86 NOAA.

WINTER OVERSEEDING UNDER GOLF GREENS CONDITIONS

Objective: To evaluate the performance of selected winter overseeding grasses when established in large plots (approx. 1200 sq. ft.) and subjected to limited play.

Location of Trial:

NCSU Faculty Club Golf Course

Cooperators:

Mr. Harry Anderson and Mr. Paul Baker

Base Turf Tifgreen bermudagrass

Date of Establishment:

October 3, 1980
October 8, 1979

Seeding Rate

1980-1981 trials were seeded at 30 lbs/1000 sq. ft. except for those entries which contained Sabre rough bluegrass in the mix which were seeded at 20 lbs/1000 sq. ft. 1979-1980 trials were seeded at 40 lbs/1000 sq. ft.

Culture: Nitrogen was applied at approximately 0.5 lbs of N per 1000 sq. ft. from November through April every three weeks with no fertilization in January. Beginning in May a rate of 1 lb of N per 1000 sq ft per month was applied. In 1979-1980 IBDU (20-0-16) was the fertilization source. In 1980-1981, all plots were split in half with one-half receiving IBDU (20-0-16) and the other SCU (20-5-10-17S) mini-prill fertilizer.

Cutting height was 1/4 inch until April at which time this was lowered first to 7/32 inch and then 3/16 by mid-April. Cutting height was then gradually lowered to 3/32 inch by 5/27/81.

The greens had been verticut and soil cored by 4/29/81. Verticutting (2 ways) was again conducted on 5/28/81 and the greens were soil cored on 5/14/81 as well.

Summary: January 1981 temperatures averaged some 5.9 F below normal. These low temperatures are reflected in the poor turf quality of the overseeding species during this month (Table 2). Warmer weather began in the second week of February 1981 and by March the overseeding had reached their peak quality. The

overall differences in performance of the 9 entries studied in the 1980-1981 trial was slight. However, significant differences were present during both fall and spring transition. During the fall of 1980 entries which included Sabre rough bluegrass had reduced quality compared to those entries containing ryegrass alone. This was not the case during fall of 1979 where the inclusion of Sabre improved quality ratings over ryegrass alone entries (Table 3) Fall 1980 turned cold quite quickly compared to 1979 and probably did not allow sufficient time for adequate germination of the Sabre. Entries which included Sabre significantly suppressed bermudagrass growth during the 1981 spring transition (Table 2). Cultural practices during the spring may need to be modified for overseeding which includes Sabre rough bluegrass. Certainly, additional study in this regard is in order. Inclusion of Sabre did improve winter and early spring performance of these grasses for both years of this investigation (Tables 2 and 3).

Winter overseeding entries were studied for their performance under IBDU and SCU fertilization during the 1980-1981 trials (Table 4). The quality of overseeded turf tended to be improved under IBDU fertilization compared to SCU. This response was reversed as the greens moved back to bermudagrass, at which time SCU fertilization tended to improve the turfgrass quality of the golf greens. This response may be due to differences in the grass species and/or a result of the higher rates of fertilization imposed beginning in May. Additional investigation of this response would help clarify these observations.

Table 2. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding trial under golf green conditions in Raleigh, N. C.

Entry	Date							
	Nov.	Jan.	Feb.	Mar.	Apr.	May	June[1]	Mean
Legend Perennial	5.7a*	4.8a	5.4abc	6.4ab	5.3a	5.9a	5.9a	5.6a
WinterTurf I	6.0a	4.3a	6.2a	5.9ab	5.2ab	5.5a	6.1a	5.6a
CBS Blend	6.0a	4.8a	5.4abc	6.6a	5.0ab	5.7a	5.5ab	5.6a
Legend	5.8ab	4.7a	5.8abc	5.8ab	4.9ab	5.3a	6.3a	5.5ab
Marvelgreen Supreme	5.8ab	4.8a	5.4abc	6.1ab	4.8ab	5.2a	6.2a	5.5ab
WinterTurf III	6.2a	4.5a	5.2bc	5.9ab	5.3a	5.1a	5.5ab	5.4ab
Marvelgreen + Sabre	5.0b	4.7a	6.3a	6.3ab	5.6a	5.8a	3.6c	5.3ab
Marvelgreen 3+1	5.0b	4.3a	4.9c	6.0ab	5.0ab	5.4a	6.1a	5.3ab
Legend + Sabre	5.0b	4.2a	5.4abc	5.6b	4.3b	5.7a	4.8b	5.0c
Mean**	5.6b	4.6d	5.6b	6.1a	5.0c	5.5b	5.5b	

[1]Ratings for the month of June include the quality of Tifgreen bermudagrass present as well.

*Means with like letters within a column are not significantly different at the 0.05 level according to the DMRT.

**Means with like letters in this row are not significantly different at the 0.05 level according to the DMRT.

Table 3. Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding trial under golf green conditions in Raleigh.

Entry	Date					Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	
Marvelgreen + Sabre	4.0	8.7	7.5	7.2	7.3	7.0a*
Celebrity Plus	2.8	8.8	6.7	7.1	6.7	6.4b
Marvelgreen Supreme	4.3	8.4	6.5	6.1	6.3	6.3bc
WinterTurf I	4.3	8.4	6.3	6.2	6.1	6.3bc
Marvelgreen 3+1	4.0	8.1	6.2	5.8	6.0	6.0cde
Celebrity	3.3	8.2	6.3	6.0	6.0	6.0cde
Medalist 6	4.2	8.3	5.8	5.5	5.7	5.9de
Medalist 7	3.8	8.0	5.5	5.5	5.5	5.7ef
Annual Ryegrass	4.8	7.7	4.3	5.0	5.0	5.4f
Mean	4.0c	8.3a	6.1b	6.0b	6.1b	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 4. Turfgrass quality ratings (1 to 9 =best) for the 1980-1981 winter overseeding trial under golf green conditions as influenced by fertilizer source.

Entry	Date						Mean	
	Nov.		Mar.		June			
	IBDU	SCU	IBDU	SCU	IBDU	SCU	IBDU	SCU
Legend Perennial	5.7	5.7	6.8	6.0	5.3	6.5	5.6	5.6
WinterTurf I	6.3	5.7	6.7	5.2	5.8	6.3	5.8	5.4
CBS Blend	6.0	6.0	7.3	5.8	5.3	5.7	5.7	5.5
Legend	6.0	5.7	6.2	5.3	6.0	6.6	5.5	5.5
Marvelgreen Supreme	6.0	5.7	6.8	5.3	5.7	6.7	5.5	5.4
WinterTurf III	6.3	6.0	6.5	5.3	5.2	5.7	5.4	5.3
Marvelgreen + Sabre	5.0	5.0	7.0	5.7	3.8	3.3	5.5	5.2
Marvelgreen 3+1	5.0	5.0	6.3	5.7	5.5	6.6	5.2	5.3
Legend + Sabre	5.0	5.0	5.8	5.3	4.3	5.3	4.9	5.1

WINTER OVERSEEDING GENERAL EVALUATIONS

Objective: To evaluate many different winter overseeding species, mixes and blends for their performance in North Carolina under simulated golf green conditions.

Location of Trial:

NCSU Turfgrass Field Plots, Raleigh, N. C.

Base Turf: 1980-1981 Tifgreen bermudagrass -
1979-1980 General Evaluation Trial II was on both Tifgreen and Tifdwarf bermudagrass

Seeding Rate:

1980-1981 trials were seeded at 30 lbs/1000 sq. ft. except for Sabre plots which were seeded at 20 lbs/1000 sq. ft. 1979-1980 trials were seeded at 40 lbs/1000 sq. ft. except for *Poa trivialis* alone which was seeded at 10 lbs/1000 sq. ft.

Culture: Turfs were fertilized between October and April with quickly available sources (usually ammonium nitrate) at a rate of approximately 0.5 lbs N/1000 sq. ft. per month, with no fertilization during January. Fertilization after April was at a rate of 1 lb N/1000 sq. ft. per month.

Summary: Turfgrass quality was reduced in the fall of 1980 due to early cold, dry weather compared to that observed during the fall of 1979 (Tables 5 and 6). Seventeen entries were evaluated in both 1979-1980 and 1980-1981. Those entries ranked in order of best overall performance were PHD, Dixiegreen, Delray, Dixiegreen + Sabre, Goalie, Celebrity Plus, Celebrity, WinterTurf III, Elka, Derby, Barry, WinterTurf I, Medalist 7, Loretta, Caravelle, Showboat, and Dawson, (Tables 5-8). Turfgrass quality from most entries in 1980-1981 was very similar. Significantly reduced quality was observed for Loretta, Showboat, Dawson, No. 79308, and Legend EconoMix during 1980-1981.

The inclusion of Sabre significantly improved turfgrass quality ratings through March of 1979 (Tables 5-8). In general, spring transition in 1980 did not see the problems encountered in 1981. Bermudagrass growth in the spring of

1981 was reduced in areas that had not been overseeded as well. Certainly the early cool fall and cold January weather conditions coupled with a lack of rainfall influence the bermudagrass spring growth and recovery ragardless of whether or not overseeding grasses were present. Annual ryegrass was the poorest overseeding entry in all 1979-1980 tests in which it was included.

Table 5. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding trial general evaluations in Raleigh, N.C.

Entry	Date						Mean
	Nov.	Jan.	Feb.	Mar.	Apr.	May	
PHD	5.3	4.7	6.0	6.8	6.3	7.2	6.1a*
No. 7812 PR	4.7	5.0	5.7	7.0	6.3	6.7	5.9ab
Dixiegreen	5.0	4.0	5.7	6.3	6.8	7.2	5.8ab
Blend 906	5.7	4.7	4.7	7.0	6.5	6.5	5.8ab
Goalie PR	6.0	4.0	5.3	6.5	6.2	7.0	5.8ab
Regal PR	4.7	4.3	6.0	6.3	6.3	7.3	5.8ab
CBS	5.3	4.3	5.3	6.7	6.5	6.5	5.8ab
Blend 709	5.7	4.3	5.0	6.3	6.2	7.0	5.8ab
Delray PR	6.0	4.0	5.0	6.5	6.3	6.5	5.7a-d
CBS + Shadow CF	5.0	3.7	5.3	6.2	6.5	7.0	5.6a-e
WinterTurf III	4.7	4.7	5.3	6.0	6.0	6.7	5.6a-e
Eton PR	5.0	5.0	5.7	6.2	5.5	6.0	5.6a-e
Celebrity	5.0	4.3	5.3	6.2	5.7	6.8	5.6a-e
Legend 3+1	4.3	4.3	5.3	6.5	6.0	6.7	5.5a-f
Elka PR	5.3	4.3	4.0	6.2	5.7	7.3	5.5a-f
Dixiegreen + Sabre	4.0	3.3	5.3	6.5	6.2	7.2	5.4a-h
Medalists 6	5.7	4.7	4.7	6.2	5.0	6.3	5.4a-h
Caravelle PR	5.0	5.0	5.3	5.7	5.5	5.8	5.4a-h
Yorktown VI PR	5.0	4.0	5.3	6.2	5.2	6.5	5.4a-h
R-40 PR	4.3	4.0	5.0	6.3	6.0	6.5	5.4a-h
Barry P.R.	5.3	4.0	4.7	5.8	5.5	6.3	5.3b-h
WinterTurf I	6.0	4.3	4.3	6.0	4.7	6.3	5.3b-h
Medalist 7	5.0	4.3	4.7	6.0	5.3	6.3	5.3b-h
No. 79309 PR	5.3	3.7	5.0	5.8	5.7	6.2	5.3b-h
Derby PR	4.0	4.7	5.0	5.8	5.5	6.5	5.3b-h
Citation PR	5.3	4.0	4.7	5.8	4.8	6.7	5.2b-i
CBS + Oregreen	4.7	4.3	5.3	5.7	4.8	6.3	5.2b-i
Celebrity Plus	4.0	3.3	5.0	6.0	6.0	6.8	5.2b-i
Diplomat PR	4.3	3.7	4.7	5.8	5.5	6.5	5.1c-i
No. 79307 PR	4.3	4.0	4.7	5.3	6.0	6.0	5.1c-i
Loretta PR	4.3	4.0	4.0	6.2	4.7	6.3	4.9e-i
Showboat Mix	4.3	4.0	5.0	5.7	4.7	5.7	4.9e-i
Dawson RF	4.3	2.0	3.0	6.2	5.8	7.3	4.8ghi
No. 79308 PR	4.3	3.3	4.0	5.0	5.7	6.0	4.7hi
Legend EconoMix	4.3	4.3	5.7	4.7	4.0	4.7	4.6i
Mean	4.9d	4.1e	5.0d	6.1b	5.7c	6.5a	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 6. Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding general evaluation trial I in Raleigh, N. C.

Entry	Date						Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
Dixiegreen + Sabre	8.8	8.2	6.5	7.2	6.0	8.5	7.5a*
Delray PR	8.7	8.6	6.0	6.3	5.5	8.7	7.3ab
PHD	8.2	8.6	6.0	6.7	5.3	8.5	7.2abc
Loretta PR	8.8	8.6	6.0	6.5	5.0	8.5	7.2abc
Fiesta PR	8.5	8.6	6.2	5.8	5.5	8.5	7.2abc
WinterTurf I	8.4	8.4	6.0	6.1	5.2	8.7	7.1bcd
Blazer PR	8.2	8.5	5.8	6.3	5.5	8.3	7.1bcd
Diplomat/Jam/Sabre	8.2	8.5	5.3	6.8	5.5	8.2	7.1bcd
Barry PR	8.2	8.6	5.8	6.3	5.2	8.2	7.1bcd
Futura	8.3	8.5	5.7	6.7	5.3	7.8	7.1bcd
Derby PR	7.9	8.3	5.5	6.5	5.7	8.3	7.0c-g
Acclaim PR	8.4	8.1	5.8	6.2	5.0	8.2	7.0c-g
Goalie PR	8.5	8.7	5.3	6.3	4.8	8.0	7.0c-g
Medalist 7	8.5	8.5	5.3	6.3	5.0	8.0	6.9c-h
Elka PR	8.9	8.9	5.2	5.5	4.5	8.5	6.9c-h
Dasher PR	8.3	8.5	5.3	6.0	5.2	8.0	6.9c-h
WinterTurf III	8.0	8.0	5.3	6.9	5.2	7.8	6.9c-h
Dawson RF	8.6	8.8	6.0	6.3	4.2	7.3	6.9c-h
Hunter PR	8.1	8.4	5.7	5.8	5.0	8.0	6.8c-i
York II/Dip/Derb/ Jam/Sab	8.3	8.3	5.2	6.7	4.5	8.0	6.8c-i
Showboat	8.2	8.2	4.7	6.3	5.3	7.8	6.8c-i
Belle PR	8.5	8.2	4.5	5.8	4.7	8.2	6.7e-i
K5-94 RF	8.5	8.3	4.7	5.3	4.8	8.0	6.6g-j
Ino RB	6.5	7.4	5.7	6.5	5.3	8.2	6.6g-j
Sabre RB	6.3	7.4	5.8	6.7	5.0	8.3	6.6g-j
K5-29 RF	8.3	8.3	5.2	6.3	4.3	6.8	6.6g-j
Caravelle PR	7.6	8.0	5.2	6.0	4.5	7.5	6.5ijk
K4-21 RF	7.7	8.0	5.0	5.3	4.0	7.3	6.2jk
Annual Ryegrass	7.4	7.5	4.2	5.8	5.0	7.2	6.2jk
Mean	8.2ab	8.3a	5.5d	6.3c	5.0e	8.1b	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 7 . Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding general evaluation trial II.

Entry	Date						Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
Dixiegreen + Sabre	7.8	8.9	7.1	7.5	6.3	8.8	7.7a*
Marvelgreen + Sabre	7.4	8.7	7.3	7.6	6.2	9.0	7.7a
WinterTurf I	7.4	8.6	6.5	7.2	5.8	8.5	7.3b
Medalist 7	7.7	8.7	6.5	7.0	5.0	8.5	7.2b
Annual Reygrass	6.5	7.4	4.8	5.3	5.3	7.0	6.1c
Mean	7.4b	8.5a	6.5d	6.9c	5.7e	8.4a	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 8 . Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding mix and blend general evaluation trial III.

Entry	Date						Mean
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	
Celebrity Plus	8.7	8.6	6.5	7.5	5.8	8.5	7.6a*
York II/Derb/Dip/ Jam/Sab	8.7	8.5	6.3	7.5	5.5	8.8	7.5ab
Dixiegreen + Sabre 8:2	8.5	8.6	6.1	7.5	5.9	7.9	7.4abc
Dixiegreen + Sabre 7:3	8.0	8.3	6.1	7.4	5.9	8.4	7.4abc
NK 78100	8.3	8.7	5.8	7.3	5.1	8.4	7.3cde
Dip/Jam/Sabre	8.2	8.3	6.0	7.2	5.6	8.3	7.2cde
Marvelgreen + Sabre	8.3	8.2	6.0	7.3	5.5	8.1	7.2cde
Marvelgreen Supreme	8.2	8.4	5.9	7.2	5.4	8.3	7.2cde
NK 79500	8.4	8.7	5.6	7.2	5.3	8.0	7.2cde
Marvelgreen 3+1	8.3	8.5	6.0	7.2	5.0	7.9	7.1def
WinterTurf I	8.1	8.2	5.9	7.2	5.1	8.1	7.1def
Medalist 6	8.3	8.3	5.8	7.1	5.1	7.9	7.1def
Celebrity	8.4	8.4	5.8	7.0	4.8	7.6	7.0fgh
WinterTurf III	8.0	8.2	5.9	6.9	4.9	7.8	6.9fgh
Showboat	8.0	7.9	5.5	6.8	5.6	7.6	6.9fgh
PHD	8.1	8.0	5.8	7.0	4.9	7.6	6.9fgh
Medalist 7	8.2	8.1	5.4	6.7	4.9	7.8	6.8h
Mean	8.3a	8.3a	5.9d	7.2c	5.3e	8.0b	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

OVERSEEDING OF GOLF GREEN COLLARS

Objective: To examine the potential use of cool season turfgrass species for the winter overseeding of bentgrass golf green collars bordered by common bermudagrass fairways. In 1980 this objectived was expanded to include an evaluation of each entry's performance during the summer in North Carolina

Location of Trial:

Shamrock Golf Club, Burlington, N. C.

Cooperators:

Mr. Calvin Walker and Mr. Steve Walker

Base Turf: Common bermudagrass

Date of Establishment

October 8, 1980
October 24, 1979

Seeding Rate:

Plots were seeded at 15 and 10 lbs/1000 sq. ft. in 1980, while all plots were seeded in 1979 at 20 lbs/1000 sq. ft.

Culture: Fertilization was approximately 1/2 lb N/1000 sq. ft. and collars were cut at a height of 1/2 inch as needed.

Summary: This investigation encompassed two single year studies. The main objective in 1979 was to evaluate the use of overseeded grasses as distinct, well defined collars around bentgrass greens which are encircled by common bermudagrass fairways. In the absence of such overseeding these collars are often ragged as a result of the encroachment of the bentgrass into the bermudagrass and vice versa. All entries in the 1979-1980 trial provided acceptable quality as measured in February and April (Table 9). PHD + Sabre, Medalist 5, and Marvelgreen + Sabre received the highest quality ratings in this trial.

In 1980 the research objective for this study was expanded to include the evaluation of selected overseeding mixes for permanent establishment. This objective necessarily requires summer performance and survival. WinterTurf I ranked highest in overall turfgrass quality in the 1980-1981 collar test (Table 10). Sports Turf had poor winter performance in 1981, but its quality improved to equal that of WinterTurf I in July .

General observations during this study include the note that Poa annua seed was apparently wiped off shoes and wheels as they entered the green, thus reducing this weed problem. Weed problems with the collar themselves were most evident at the approaches to the green where traffic was most severe.

Table 9. Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding of golf green collars in Burlington, N. C.

Entry	Date		Mean
	Feb.	Apr.	
PHD + Sabre	8.3	8.0	8.2a*
Medalist 5	8.2	7.4	7.8ab
Marvelgreen + Sabre	8.2	7.2	7.7ab
Marvelgreen 3+1	7.8	7.3	7.6b
Medalist 6	7.8	7.1	7.5b
Medalist + 400	7.3	6.5	6.9c

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 10. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding of golf green collars in Burlington, N. C.

Entry	Date						Mean
	Jan.		Feb.		Jul.		
	Seed rate[1]		Seed Rate		Seed Rate		
	15	10	15	10	15	10	
WinterTurf I	5.7	4.7	8.0	6.3	7.3	7.2	6.5a*
CBS + Columbia KB	5.3	4.3	7.0	6.0	7.2	6.9	6.2ab
Marvelgreen 3+1	5.3	4.0	6.7	5.9	6.9	6.4	5.9cb
Legend	5.0	4.0	7.3	5.7	6.7	6.2	5.8cb
Sports Turf	4.7	3.3	6.0	4.3	7.3	7.2	5.5cd
Loft's Mix	4.3	4.0	5.3	4.3	6.2	6.0	5.0d

[1]Seed rate was 15 and 10 lbs per 1000 sq ft.

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

WINTER OVERSEEDING FOR TEMPORARY GOLF GREENS

Objective: To determine the utility of winter overseeding grasses for establishing temporary golf greens for use during weather extremes when play on the permanent bentgrass greens would be objectionable.

Location of Trial:

Raleigh Country Club, Raleigh, N. C.

Cooperator:

Mr. John Rosser

Base Turf: Common bermudagrass

Date of Establishment:

October 13, 1980
October 15, 1979

Seeding Rate:

All plots were seeded at a rate of 30 lbs/1000 sq. ft.

Culture: Initial cutting height was 1/4 inch and was then lowered to 3/16 inch in February. Fertilization was approximately 1/2 lb N/1000 sq. ft. per month. No fertilization occurred in January

Summary:

The temporary greens established at the Raleigh Country Club in 1980 were utilized extensively during the cold weather of January and February. All nine entries had equivalent quality ratings as temporary greens in 1980-1981 (Table 11). Differences between entries were observed in 1979-1980 (Table 12). PHD + Sabre ranked highest, while Celebrity ranked lowest. Spring transition is not encountered with these temporary greens, as they are removed by spraying with Paraquat in March.

Table 11. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding of temporary golf greens in Raleigh, N. C.

Entry	Date			Mean
	Jan.	Feb.	Mar.	
Marvelgreen Supreme	4.6	5.7	5.7	5.3a*
Marvelgreen 3+1	4.3	5.8	6.0	5.4a
WinterTurf I	5.0	6.3	6.2	5.8a
WinterTurf III	5.0	6.0	5.8	5.6a
CBS Blend	4.0	5.5	6.0	5.2a
Legend	4.0	5.5	6.3	5.3a
Legend 3+1	4.3	6.3	6.3	5.7a
Medalist 7	3.6	5.8	5.8	5.1a
Medalist Mix (PED)	4.3	5.8	6.2	5.4a
Mean	4.4b	5.9a	6.0a	

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

Table 12. Turfgrass quality ratings (1 to 9 = best) for the 1979-1980 winter overseeding of temporary golf greens in Raleigh, N. C.

Entry	Date		Mean
	Nov.	Feb.	
PHD + Sabre	7.7	6.7	7.2a*
Celebrity Plus	7.4	6.8	7.1ab
Dixiegreen	7.7	5.8	6.8abc
Medalist 6	7.5	5.7	6.6a-d
Marvelgreen 3+1	7.3	5.8	6.6a-d
PHD	7.3	5.5	6.4a-d
Medalist 7	7.7	5.0	6.3bcd
WinterTurf I	7.0	5.5	6.3bcd
Celebrity	6.9	5.0	5.9d

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

LAWN AND FAIRWAY WINTER OVERSEEDING

Objective: To determine the minimum seeding rate required for acceptable cover and turf quality.

Location of Trial:

NCSU Turfgrass Field Plots

Base Turf: Common bermudagrass

Date of Establishment:

October 31, 1980

Seeding Rates:

3, 6, 9, 12, and 15 lbs/1000 sq. ft.

Culture: Plots were fertilized at a rate of 1/2 lb N/1000 sq. ft. per month for Nov. through April, with no fertilization in January. After April plots received 1 lb N/1000 sq. ft. per month. Cutting height was 2-1/2 inches.

Summary: Derby provided slightly improved quality after March compared to that of Oregreen (Table 13). The quality of Oregreen turfs began to decline after March with the complete loss of these stands in June. Derby plots survived into August, however cultural practices such as reduced cutting height and aerification were not conducted. Seeding at 3 lbs/1000 sq. ft. yielded unacceptable quality for both Derby and Oregreen in this trial (Table 14).

Table 13. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding of lawn and fairway common bermudagrass.

Entry	Date					Mean[1]
	Jan.	Feb.	Mar.	Apr.	May	
Derby PR	4.5ef*	5.1de	6.3ab	6.3ab	6.9a	5.8a
Oregreen	4.1f	5.9bc	7.0a	5.3cd	5.1de	5.5b

*Means with like letters do not differ significantly at the 0.05 level according to the DMRT.

[1]Do not use DMRT letter designations to compare this parameter to date means.

Table 14. Turfgrass quality ratings (1 to 9 = best) for the 1980-1981 winter overseeding of lawns and fairway common bermudagrass with various seeding rates of Oregreen and Derby ryegrass.

Entry	Seeding Rate (lbs/1000 sq ft)				
	3	6	9	12	15
Derby	4.3	5.8	6.5	6.2	6.3
Oregreen	4.2	5.3	6.0	5.8	6.1
Mean	4.3c*	5.6b	6.3a	6.0ab	6.2a

*Mean with like letters do not differ significantly at the 0.05 level according to the DMRT.

ACKNOWLEDGEMENTS

The cooperation and generous seed supply by the following companies is gratefully acknowledged.

E. F. Burlingham & Sons
E. J. Smith & Sons
International Seeds
Lofts Seed Inc.
North American Plant Breeders
Northrup King Company
O. M. Scott & Sons
Pickseed West Inc.
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These studies were partially funded by Lofts Seed, Inc. during 1980-1981

RENOVATION OF BENTGRASS GREENS BY SODDING

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Grove Park Inn Country Club is located in Asheville, N. C. It was first known as the Swannanoa Hunt Club, then the Asheville Country Club and became the Grove Park Inn Country Club in 1977. The golf course was built in 1893 with some renovation of the greens in 1930. The greens were built on clay and a large amount of thatch has accumulated over the years. Annual bluegrass makes up the greatest percentage of the turf with patches of several of the old bentgrasses and some Penncross bentgrass present. It has become almost impossible to grow acceptable quality turf on these greens during the hot and humid summer months. The decision was made to rebuild several of the greens each year to help overcome this problem.

Sodding was determined to be the quickest, easiest and most inexpensive method to use in rebuilding the greens for this club because of a shortage of money, equipment and labor and the problem of not being able to do the work during the summer due to heavy convention use. A site was selected for a nursery that was out of play and that was reasonably level. The site was sprayed with 4 ounces of Roundup per 1000 sq. ft. the first week in August. The area was tilled with a rotavator on a three point hitch in two directions the third week in August. The soil was leveled with a worn-out flail mower, and the dead grass and rocks were removed by raking. One area of 22,000 sq. ft. was fertilized with 10 pounds of 10-10-10 per 1000 sq. ft. and seeded with 2 1/2 pounds of Penncross bentgrass seeds on August 27, 1980. The seeds were mixed with milorganite and spread with a broadcast type seeded. The seeds were pressed into the soil by running over the area three times with a Brillon seeder behind a tractor. The area was irrigated as needed to keep it moist, and some seedlings emerged after four days. The grass was mowed at 1/2 inch for the first time on September 17. Another area of 43,000 sq. ft. that was treated with Roundup on August 4 and tilled on August 26 was planted as previously described on September 10. The soil was not fumigated with methyl bromide before planting.

The nursery areas were observed carefully to keep the soil moisture at proper levels. Fungicides and insecticides were sprayed as needed. The areas were fertilized with 1

pound of nitrogen using 16-4-8 about every 10 days during the next two months. The sod nurseries were mowed at 3/8 inch and had excellent turf that was ready to use on greens by the end of October.

When the sod was ready, the renovation of three greens was begun. The old sod was removed from greens with a box blade behind a 36 horse power Ford tractor. The old sod and some topsoil was pulled into piles and hauled away in a dump truck. The irrigation heads were dug up and replaced with new ones of proper size. After the old sod was removed, number 2S concrete sand was dumped on the greens and spread to a depth of at least 8 inches with the box blade. The sand was floated and smoothed with a Sand Pro until desirable grades and slopes were obtained. After the final grades were present, the greens were fertilized with 1 pound of nitrogen per 1000 sq. ft. from 10-10-10 and with 6 pounds of 0-0-60 per 1000 sq. ft. The greens were irrigated heavily to help make the sand firmer for the sod.

The sod in the nurseries was cut deep, about 3/4 inch, into 6 to 8 foot lengths and rolled. The sod was hauled to the prepared greens and placed on the firm sand. Just before laying a roll of sod, the sand was raked to obtain a smoother surface. The sod was first rolled with a small asphalt roller and then with a larger roller pulled behind a Cushman truckster. The edges of the green became smooth following this operation.

The total cost per green was $2,300 except for labor, and the greens were not out of play during the busy summer season. These greens were excellent during the following summer, whereas the old greens had the usual problems. The root systems were 8 to 10 inches deep on the new greens during the hottest part of the year. This system of greens renovation has worked well at Grove Park Inn Country Club. Three to four other greens will be renovated each year using this method until all of the greens are rebuilt.

RENOVATION OF BENTGRASS GREENS WITH FUMIGATION

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The decision was made to renovate the greens on the number one golf course at Pinehurst Country Club in 1981 since it had become difficult to manage the bentgrass turf. Our intentions were to use the USGA recommendations for resurfacing greens when this project was started. That method involves verticutting greens, aerifying, sterilizing greens with methyl bromide, filling aerification holes with sand and reseeding. However, due to the severe compaction problems in the soil, a different renovation method was needed to modify the soil in the root zone. The greens were converted from sand to grass in 1937 by bringing in soil high in organic matter for the surface of the greens. The addition of organic matter and fine soil over the years had reduced the infiltration rate of water to about 0.1 inch per hour. We decided to rebuild all eighteen of the greens to a certain extent, and at the same time, enlarge them back to their original size.

The sod was removed from the greens with a sod cutter from August 17 through August 24. A mixture of 4 parts sand and 1 part Turface by volume was hauled onto the greens and spread to a depth of about 4 inches. This mixture was mixed with appoximately the top 4 inches of the existing soil by rototilling as deep as possible with a rotovator. Southern Turf was contracted to float and recontour the greens to provide good surface drainage. The greens were treated with methyl bromide by Hendricks and Dale on September 4. The plastic cover remained on the greens for 4 days since other projects had to be done before we had time to remove the cover and we didn't want the soil surface exposed any longer than necessary. In the meantime, soil samples were sent to Texas A & M University for analysis. The mixture after rototilling had an ideal infiltration rate of 6 inches of water per hour, a bulk density of 1.48 and a water retention of 13.7%.

The plastic was removed on September 8 and the greens were floated once to give a smooth surface for seeding. Penncross bentgrass was seeded at the heavy rate of 3.75 pounds per 1000 sq. ft. on September 14 and 15. The seeds were covered with soil by dragging an inverted carpet behind a golf cart. Some other method of dragging would have given better results. The greens were watered 4 times a day for

10 minutes each time at 7 am, 10 am, 1 pm and 4pm to keep the soil surface moist but not wet. The first seedlings were observed on September 19. Diseases were not a problem during the establishment period. We would suggest using 3 pounds of seeds per 1000 sq. ft. and using another dragging method in the future.

The greens were being mowed at 1/2 inch on October 5 and looked good. Root development was at least 7 inches deep on October 20. The greens were verticut on October 30 to thin out some over-populated areas, topdresssed and rolled to help smooth and firm the surface. Fertilization with nitrogen was kept to a minimum with a total of 1.5 pounds per 1000 sq. ft. being applied. This was about one half the amount that would normally be used during this time of year. Some nitrogen was probably available from the organic matter in the soil.

The greens were playable and were opened for play by members for one week on December 14. The course was closed during the winter and will open in the spring. The only major problem has been some pink snow mold that developed during extended periods of cold-wet weather in early January. This method of greens renovation has been relatively inexpensive and should give good results for many years.

INTERNATIONAL TURFGRASS SOCIETY

IVTH RESEARCH CONFERENCE AND TOURS

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Twenty-one countries were represented at the IVth I.T.S. Research Conference held July 19-23, 1981 at the University of Guelph. Two hundred and thirty-seven people registered, and 71 papers were presented in 5 different sessions: (1) Breeding and Cultivar Evaluation, (2) Establishment and Management, (3) Soils, Irrigation and Nutrition, (4) Plant Protection, (5) Physiology and Plant Pathology.

The papers were published in full in a Conference Proceedings that was made available to all registrants and to others interested in Turf Management.

The International Turfgrass Society was formed in 1969 to provide a forum for exchange of information among turfgrass researchers from different countries. The first meeting was held in Harrogate, England. Subsequent conferences took place in Blacksburg, Virginia in 1973, and in Munich, Germany in 1977.

Pre-conference and post-conference tours were organized. These tours provided an opportunity for non-Canadians (and some Canadians, too) to see turf management in various parts of the country.

The pre-conference tour began in Montreal. Golf courses, sod farms, playing fields and research trials were visited in Quebec and Ontario. There were 52 people from 13 countries on this tour.

The post-conference tour travelled by air to Calgary, Alberta - then by bus to Banff, Alberta, through the mountains to Vancouver, British Columbia, and then to Washington and Oregon. There were 54 people on this tour from 11 countries.

The conference and the associated tours helped bring together Canadian turfgrass researchers, sod growers, golf course superintendents, park managers, and suppliers. Hopefully those attending from other countries also benefitted from the meetings and the visits.

Presented to the 20th Annual North Carolina Turf Conference, Raleigh, N.C., January 14, 1982.

BUNKER MAINTENANCE

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A bunker is defined in The Rules of Golf as an area of bare ground, often a depression, which is usually covered with sand. Grass covered ground bordering or within a bunker is not part of the hazard. The grassy hollows discussed in the rough chapter are not hazards. Thus a "grass bunker" is a misnomer for grassy hollow and is not a true hazard. Bunkers are sometimes called sand traps. This usage has become commonly accepted even though the word trap doesn't exist in the official Rules of Golf.

Bunkers function in directing traffic patterns of players and golf carts. They also function in providing depth perception, protection around tight green-tee areas to prevent balls from bouncing onto tees and into players.

There are two basic types of bunkers, termed the fairway and greenside bunkers. There are no prescribed limits for the size and shape of bunkers. The primary function of a bunker is to exact a penalty for a misshot. It should be a more difficult shot than from the fairway or greenside lie.

Bunkers can greatly enhance the golfing landscape due to the striking contrast in color between sand and healthy turf. This can be true whether the bunkers are large or small. The tendency today is to design for powered rakes to minimize hand raking, especially where a modest operating budget is anticipated. Most 18 hole courses today are designed with 40 to 80 bunkers. Additional bunkers are sometimes added or some are removed or realigned as play may dictate.

The face of a bunker is generally that part nearest the green, whereas those located behind the green will usually have their main face the slope away from the green surfaces. The height may vary with the terrain or the shot envisioned by the architect.

The upper part of the bunker face is defined by a vertical lip usually two to four inches high about the sand line. The grassy lip serves three purposes: prevents the golfer from putting out, prevents shots hit in the bunker from rolling out, and to define the edge of the bunker for trimming purposes. The lip should be next to the green.

This is a difficult part of the bunker to maintain. The irrigation system is not designed properly for the lip area. A small drip irrigation line in the grass root zone about six or eight inches deep and from the edge may be the best solution.

Mechanical machinery is the best method for keeping a neat trimmed edge. Convenient chemicals or hand labor can be utilized to keep the lip neat.

Drainage is very important and can prevent slowing of play if water stands after irrigation or rains. Otherwise it will be necessary to have a pump or siphon to remove the water from the undrained bunkers.

Sand particle size is one of the most important parts of a bunker. The sand can affect the entire round of golf. The suggested size of sand should be from .25 mm to 1.00 mm. A sharp sand is preferable. The ball-bearing particle should be avoided. Sand in the bunker should be four to six inches deep at the base and about two inches on the face. Shallow two-inch sand will allow the ball to land without burying and rolling down to the base of the bunker. Repair of the face is reduced as the golfer does not climb to play a shot.

The two-inch depth sand is about 6.2 cubic yards per 1,000 sq. ft. while four-inch depth of sand is about 12.4 cu. yds./1,000 sq. ft. The depth of the fairway bunker is less--about two inches.

From a maintenance point of view, greenside bunkers should be situated no closer than 10 to 12 feet from the putting surface. The separation allows the green mowers free turning areas without restriction. This distance also reduces sand being hit onto or wind blowing sand onto the greens. The traffic will have a chance for a fast and orderly movement. There will be a reduction in thinning of turf, less wear and compaction.

Wind movement of sand can be affected by design and particle size. Hard silicate type sands are preferred to soft calcareous sands such as coral sands. Be sure to inspect each truck of sand to insure the sand is acceptable before dumping.

Filling the bunkers can be done by trucks or by hand. Spreading the sand can be done by a blade or by hand. Recently a superintendent filled his bunkers by using a "gunite" machine. He was able to save 50% in money and the sand was compacted as if it had been in place for several months.

The cost of maintaining bunkers can be expensive but the power rake for bunkers has been an innovation. It has saved clubs thousands of dollars in raking alone.

Sodding around the bunker edges can be done with several grasses such as zoysia, centipede, bermuda, bluegrass and others, depending on where the bunker is located.

The bunker is one of the expensive areas of a golf course to maintain; however, a neatly kept bunker adds much to the appearance of the course.

CONVERTING BLUEGRASS FAIRWAYS TO BERMUDAGRASS

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When I assumed the position of superintendent at Beaver Brook Country Club in Knoxville, TN, we had bluegrass fairways. In the spring and fall they provided our membership with quality turf. However, in the summer the fairways would thin out and disease was a constant problem.

After nursing the bluegrass fairways for several years I convinced our members to sprig bermudagrass. Since the winters in Knoxville can be quite severe, I decided to have Southern Turf Nurseries from Tifton, GA to sprig Midiron (P-16) into our fairways.

The first step was to spray our fairways with Paraquat at a rate of 1 qt/ac. This was done one week before Southern Turf arrived to sprig our fairways. Next we had to water our fairways heavily for several days. This enabled Southern Turf's sprigger to operate smoothly in our clay loam type soil.

We kept the Midiron sprigs in the rough close to an irrigation outlet. This was done so they could be kept moist while the sprigging was taking place.

The sprigger that was sent to sprig our fairways had the capability to plant five rows in one pass. It had five large blades to slice the ground, each blade was followed by a subsoiler, which opened up the ground for the sprigs. Next came a smaller blade which would press the sprigs into the trench. This was followed by a mechanical arm that would close the trench together. The sprigger had a trailing roller to aid in leveling the trench. Two men were required to ride in the back of the sprigging machine to feed the five conveyors.

Uneven areas in the fairways came up in small chunks. These areas were repaired by hand before they were rolled by our heavy fairway roller. Our large roller assured us of obtaining good contact between the sprigs and the soil.

Slopes around the greens were difficult to sprig using the sprigger; therefore, hand labor had to be utilized in these areas. Shovels were used to slit the ground and a handful of sprigs was put it.

As soon as the sprigger and fairway roller would finish a fairway, we immediately began watering. Water was very essential to the young sprigs. During the first two weeks the fairways were watered twice a day every day. It was important to keep the fairways saturated during this period of time. The slopes around the greens required portable irrigation heads. Sprigs exposed above the ground turned brown, but after 2-3 weeks

of constant watering and hot summer days the sprigs that were several inches underground began to emerge. At this time I began to decrease our watering schedule to 4 days/week and just once a day.

Our next problem started to become evident; crabgrass and goosegrass started germinating due to the heavy watering and summer heat. During the last week in June (4 weeks after planting) we sprayed Daconate 6 @ 43 oz/ac plus Sencor @ 1/2 lb/ac. This we mixed with a wetting agent and applied in a fairway sprayer using 25 gal of water per acre. We followed seven days later with an application of Daconate 6 without Sencor. The same procedure was repeated in mid-August to eliminate any late season weeds.

After the first spraying in June we applied two applications of ammonium nitrate at a rate of 130 lbs per acre and raised the height of cut to 1-1/4 inches. We did this to increase the chances of having 100% survival during its first critical winter.

We had some native bermuda which offered some areas of turf to hit shots from instead of a tee which all players could use in the sprigged fairways. These areas of bermuda began to spread rapidly once the competitive weeds were eliminated.

Overall, the sprigging came out better than I had expected. By October we had achieved 90-100% coverage of our fairways and approximately 80% coverage on the slopes around the greens.

When visiting the course a year later, I found much thicker fairways and the slopes around the greens were completely covered, very thick, and immaculate.

OAKLAND PLANTATION GRASS

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In the past the major complaints concerning the use of our hybrid bermuda sod on golf greens have been the high mowing height and the excessive thatch. In regard to these problems we at Oakland have derived a sod cut especially for the use on golf greens. With this low cut, thatchless sod it is now possible to install or repair a green and have an acceptable putting surface within three to five days.

Specifications: Tifton 328 (Tifgreen)

Total height	1"
mowing height	1/2"
soil and root zone	1/2"
Total length	72"
Total width	18"

Procedures for installing Oakland "short cut" without changing the contours of the green.

Step 1. Using a sodcutter (set at 1") cut old grass off green. (Hint, make a perimeter cut completely around green. Then work from the inside out.)

Step 2. Use a garden rake or sandtrap rake and rake debris off surface.

Step 3. Using an aerator or spiker go completely over green. Holes should be approximately 6 to 8 in. apart and 1" to 2" deep.

Step 4. Rake plugs off green.

Step 5. Laying Oakland "short cut" sod. If green has a definite drainage pattern, lay sod across drainage direction. Use a bush axe or serrated knife to trim sod to fit green. It is important to fit seams as tightly as possible. The tighter the seam, the quicker the recovery.

Step 6. Use a light to medium weight roller to firm sod in place.

Step 7. Manually topdress all seams.

Step 8. Use irrigation to settle topdressing material

Step 9. The next day topdress entire green using twice the amount of normal application.

Step 10. Irrigate green 2 to 3 hours (more or less according to amount needed to settle topdressing material.

Third day, use a walk behind greens mower and mow at 1/2".

Step 12. Fourth and fifth day, bring mowing height down to normal playing height. Resume regular maintenance.

WEED CONTROL ON GOLF COURSE GREENS

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Many turf management practices are basic to weed management of grass and broadleaf weeds in bermudagrass and bentgrass greens. Several effective herbicide products are available for the control or lessening the infestation of these weeds. However, weed management in turf requires a sound turf maintenance program together with a planned herbicide program. Neither program alone will control weeds. The golf superintendent can control weeds with herbicides and good management, though failure in either program may result in an infestation of weeds.

A dense turf is the best protection against invasion by weeds. A total weed management program in turf, therefore, includes:

1) Correct fertilization will produce even growth and maintain turf density throughout the season. Turf density and vigor needs to be maintained through the winter months to reduce infestation by winter annual weeds. Spring fertilization helps to maintain turf density and vigor through the peak periods of crabgrass germination in the spring and summer. Fertilization practices should meet the needs of the particular turfgrass. Avoid overapplication of fertilizers which may burn or thin turf thereby permitting the invasion of weedy species.

2) Regular mowing at proper heights helps to develop a dense turf cover. In contrast, mowing too close or at long intervals may scalp the grass and open the turf to weed invasion.

3) Also proper watering practices that prevent drought stress help maintain a dense turf.

4) Aeration and dethatching should be timed to avoid the peak period of crabgrass germination. Early spring would be the best time for renovation before crabgrass germination. Then follow this with a preemergence herbicide application. However any aeration following preemergence application would tend to destroy the herbicide barrier and encourage the germination of crabgrass seedlings, which means that it would be necessary to follow such an aeration with a postemergence herbicide program for control of any crabgrass which may emerge. Fall renovation should be done before time for annual bluegrass germination and then followed with herbicides for control of annual bluegrass.

5) Insect and disease control is essential to maintaining a dense turf cover. This is also part of the weed management program which is essential to prevent infestation of weeds.

6) The last part of the weed management program is careful selection of preemergence and postemergence herbicides for the control of the specific weed which exists in the golf green. Preemergence herbicides must be applied prior to germination of weed species. In golf greens preemergence materials are primarily used for control of smooth and large crabgrass and annual bluegrass. In sections of the state with a longer frost-free period, a second application of a preemergence herbicide may be necessary to maintain control through the growing season.

Preemergence Control of Crabgrass

A number of very good herbicides have been developed for crabgrass control in turf. Only bensulide (Betasan, Pre-San, Lescosan, and Betamax) is labelled for use on bermudagrass and bentgrass greens. Benefin (Balan), DCPA (Dacthal), oxadiazon (Ronstar) should not be used on bentgrass. These same three herbicides are labelled for bermudagrass but are not suggested for use on bermudagrass greens. Siduron (Tupersan) may be used on certain bentgrass cultivars. It is not suggested for use on bentgrass greens because its effect on greens may vary with turf management practices and environmental conditions. Since crabgrass may germinate from April through September in North Carolina, bensulide cannot be expected to provide season-long control from a single application. Time preemergence applications when the dogwoods are in full bloom in your area. A second application may be needed 10 to 12 weeks after the first. A suggested rate per application would be 8 lbs active/A. After spraying, bensulide must be activated by watering into the soil. Failure to activate the herbicide either by watering or rainfall will result in poorer crabgrass control. Bensulide must be applied uniformly at a rate to develop a protective layer near the soil surface. As the seed begins to germinate the herbicide is taken in by the seedling and the plant is killed.

Spraying techniques contribute to the success of your weed control practices whether applying preemergence materials or postemergence materials. They include: 1) applying the spray uniformly, 2) avoiding skips or excessive overlaps, 3) selecting the proper rate according to the weeds being controlled and the tolerance of the bentgrass or bermudagrass, 5) using precision equipment, which includes a boom sprayer, fan nozzles, dripless nozzles, pressure regulator, tank agitation, etc., 6) employing a reliable spray person, and 7) wearing protective clothing while spraying.

The presence of thatch may influence the performance of preemergence herbicides. Generally, thatch does not reduce the efficacy of the herbicides. In some cases there is an increase in turf injury with increased thatch accumulation. Herbicides have greater mobility and availability within the thatch layers than within the soil. Also, thatch alters herbicide persistence for herbicides degrade more rapidly in the presence of thatch.

Generally, Tifdwarf bermudagrass is more sensitive to herbicides, both preemergence and postemergence applied herbicides, than Tifgreen.

Do not apply herbicides to bermudagrass immediately prior to spring green-up or during early spring green-up. This is true for preemergence applied herbicides such as bensulide and a postemergence application of Paraquat, 2,4-D,MCPP or Banvel. The preemergence herbicide bensulide, should not be applied at this time because it is a mitotic root inhibitor. Also, research has shown that during spring green-up roots of the previous season deteriorate and new roots are initiated about one week after dormancy break. Also, the meristematic root tissue of bermudagrass is highly sensitive to preemergence herbicides such as bensulide. Studies in Virginia have shown that preemergence herbicides affect post-dormancy growth of bermudagrass. They suggest that a preemergence herbicide should be applied in split applications at lower rates, application should be delayed until after bermudagrass roots are at least 5/8 inches deep and bermudagrass should be adequately fertilized.

Another aspect to the persistence of herbicides is the amount of the sand in the green. Generally, as the amount of the sand increases in greens, the residual of a herbicide decreases but also the injury of turfgrasses may be reduced. This means we may need to move to more frequent applications for season-long control from preemergence applied herbicides.

Failures with preemergence herbicides may be due to: 1) poor timing of application -- too early or too late, 2) improper application -- too low or too high a rate and failure to water the herbicide into the soil, 3) disruption of the herbicide layer -- aeration after application or traffic, and 4) movement of herbicide -- runoff or leaching due to excessive rainfall or irrigation.

Annual Bluegrass Control

A new herbicide for control of annual bluegrass (Poa annua) in dormant bermudagrass overseeded with perennial ryegrass is ethofumesate (trade name: Prograss). It provides preemergence and/or postemergence control of annual bluegrass and can be applied at overseeding or several weeks later after ryegrass has become established. Both Tifgreen and Tifdwarf bermudagrasses show tolerance to Prograss. The initial application of Prograss is applied at the time of or up to 30 days after overseeding. The rate should be 2 to 4 pints/A (1 to 2 lbs active/A) or 0.75 to 1.5 oz/1000. The label further states that one or two supplemental applications may be necessary. These applications should be made at the rate of 2 pints/A (1 lb ai/A) or 0.75 oz/1000 at 30 to 60-day intervals to maintain control through the winter. There are several use precautions with Prograss. It may cause premature onset of dormancy or injury to bermudagrass which is not fully dormant. Do not apply after February 1 or it may temporarily delay spring green-up of bermudagrass. This delay is not noticeable in bermudagrass overseeded to perennial ryegrass. Do not apply more than a total of 8 pts/A and do not use where milorgante has been applied. Good results have been obtained in experiments with two applications at a rate of 1 or 1.5 lb active/A per application at 4 and 8 weeks after overseeding of perennial ryegrass. Prograss is not labelled for use on bentgrass.

Postemergence Control of Crabgrass

Once crabgrass emerges preemergence herbicides are not effective and cultural practices provide little help. Selective postemergence control of crabgrass can be achieved with organic arsenicals (MSMA, DSMA, and CMA). Bermudagrass and bentgrass have the greatest tolerance to CMA (calcium methane arsonoate which is sold under the trade name of "Calar"). A single application of CMA at 1.5 to 2 lbs active/A in 25 to 40 gallons of water will control seedling crabgrass with one to two leaves. For more mature crabgrass plants a repeat application will be necessary 7 to 10 days after the initial application. For best crabgrass control turf should not be mowed for 2 days prior to application and temperature should be 80 to 90°. The treated turf should not be watered for 24 hours after application or mowed 2 to 3 days after application.

Broadleaf Weed Control

Broadleaf weeds are controlled with postemergence applications of 2,4-D, MCPP or Banvel. There are turf products containing all three of these herbicides, however, remember that Tifgreen, Tifdwarf and bentgrasses do show sensitivity to these herbicides. In general they are less sensitive to applications of MCPP and low rates of Banvel. Rates of 2,4-D should not exceed a rate of 0.5 lb active/A or 0.25 lb active for Banvel. In three-way combination products the rate of 2,4-D and Banvel are kept at minimum levels. This is especially true for products formulated for use on bentgrass. Avoid applying during hot, dry periods and do not irrigate for 24 hours following application.

FERTILIZER PROGRAMS FOR LAWN CARE

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When fertilizer programs for lawns are considered, one of the most important considerations is the sources of nitrogen (N) used in the program. This presentation will be primarily concerned with N sources and some of our research results using different sources in lawn fertilization programs. Emphasis on N does not mean that the other fertilizer elements (phosphorus and potassium) are not important. Unless soil test results indicate high levels of these two nutrients, they should also be included in lawn fertilization programs.

Many different sources of nitrogen can be used to fertilize lawns, and good results can be obtained with any source provided it is used properly. Proper use involves meeting the nitrogen needs of the turfgrass plant throughout the growing season without adversely affecting the quality of the turfgrass area. Application rates and timings should be based on the properties of the nitrogen source and on factors that affect release and availability of nitrogen from that source.

A number of factors may have an effect on the choice of a nitrogen source or combination of sources for lawn fertilization. The importance of these factors can be expected to vary from one lawn service company to another, and the significance of some, such as fertilizer burn, may change during the season. Among the factors are cost (slow-release types are more expensive); efficiency (quick-release types are more efficient); the method of application (dry or fluid); quickness of response desired (low or delayed response may not satisfy customers); longevity of response desired (related to the number of return visits to customers' lawns); potential for fertilizer burn (slow-release sources are safer); and soil type and irrigation practices (both influence leaching of soluble nitrogen). In most cases a program involving both slow- and quick-release sources would probably be appropriate. They could be used in combination or separately, such as quick-release types during cool weather and slow-release types during warmer weather. The nitrogen choice does not end with quick- or slow-release. Choices must be made within these categories and the properties of each source should be considered.

Quick-Release Nitrogen Sources

Quick-release sources are also called quickly-available, fast-acting, soluble, readily-available and other terms that indicate rapid availability of nitrogen after application. This group includes urea

(a synthetic organic), inorganic salts containing ammonium (NH_4^+) or nitrate (NO_3^-), and a group of urea-formaldehyde reaction products. Some urea-formaldehyde reaction products contain enough water-soluble nitrogen so that they give a response closer to that obtained with the solubles than with the slow-release sources such as activated sewage sludge, IBDU, and ureaform. The quick release sources are divided into two groups for discussion.

Inorganic salts and urea: These materials are soluble, have nitrogen (N) contents ranging from 15 to 46%, and are less expensive than slow-release sources. Being water soluble, they may be applied in solution as well as in dry form. These sources have high salt indexes and thus have high potentials for fertilizer burn. They give a rapid response and frequent applications at low rates are recommended to minimize overstimulation of growth and fertilizer burn. In general, not more than one pound of soluble N per 1000 square feet should be applied at one time to established lawns. Frequent applications of solubles can also contribute to more efficient utilization of N by minimizing losses due to leaching and luxury consumption (taking up more than needed) by the grass. The soluble sources are hygroscopic (attract moisture from the air) and may 'cake-up' in storage, particularly in damp areas or in unsealed bags or containers.

Examples of inorganic salts are diammonium phosphate (18-46-0), ammonium nitrate (33.5-0-0), ammonium sulfate (21-0-0), calcium nitrate (15-0-0), sodium nitrate (16-0-0), and potassium nitrate (13-0-44). These salts readily dissolve in water and dissociate into their cation and anion components: e.g., ammonium nitrate (NH_4NO_3) dissociates into ammonium ions (NH_4^+) and nitrate ions (NO_3^-). In the soil, nitrifying bacteria convert NH_4^+ to NO_3^- in an oxidation process called nitrification. Plants may utilize nitrogen in either the NH_4^+ or NO_3^- form, but most is taken up as NO_3^-. Nitrates are readily leached, but ammonium is less susceptible to leaching because it can be adsorbed by soil colloids (clay and humus).

Urea (46-0-0) is manufactured by reacting ammonia and carbon dioxide at greatly elevated pressure and temperature. Urea is water soluble, and is quickly hydrolyzed in the presence of the enzyme urease to form ammonium - N. More than 60% of the applied urea can be expected to hydrolyze in one day, and hydrolysis should be complete in about 7 to 10 days. Under alkaline conditions gaseous loss of N as ammonia may occur from urea or ammonium compounds. This process, called volatilization, is also favored by low soil cation exchange capacity, low soil moisture, and high temperature. Losses are usually greatest with urea; and on grass areas, losses as high as 30% of the applied N have been reported.

Soluble nitrogen sources can be dissolved in water to make solutions of varying compositions and N contents. Ammonia, ammonium nitrate, and urea are most commonly used in these solutions, which can be used for fertilizer manufacture or direct application. Mixed fertilizer solutions

containing P and/or K as well as N are also available. If fertilizer solutions can be handled and stored properly, they could offer advantages over dry materials in some lawn service operations. These concentrated solutions are relatively easy to handle and transport, and are readily diluted to the desired concentration for application alone or with pesticides.

Urea-formaldehyde Reactions Products: The best known urea-formaldehyde fertilizer is ureaform, which is a slow-release source of N with about 70% of the total N being water insoluble. By altering the ratio of urea to formaldehyde, reaction products with considerably less water-insoluble N (WIN) can be produced. The water soluble nitrogen of these products contains compounds such as unreacted urea, methylol urea, and methylene ureas. The amount of each is largely dependent on the urea/formaldehyde ratio and the conditions under which the reaction takes place. These N sources are more expensive than the conventional solubles, but they are safer from the standpoint of fertilizer burn.

Methylol urea is the first compound formed when urea and formaldehyde are chemically combined. As the reaction continues, short-chain and, later, long chain methylene urea polymers are formed. The short chain molecules are water soluble and the longer chain molecules are water insoluble. The product 'Formolene' (Hawkeye Chemical Company) is a clear, aqueous solution containing methylol urea, soluble methylene ureas, and urea to give it a nitrogen content of 30%. Such materials have a lower burn potential than urea and soluble salts containing N, and can be used more safely at higher rates or on heat or water stressed turf. However, turfgrass response is quite similar to that obtained with other solubles.

A flowable ureaform (methylene urea) suspension, FLUF, is available from W. A. Cleary Chemical Corporation. This product contains 18% N, with 20% of the total N being WIN. Quick response is obtained from this material, but it is slightly less rapid than the completely soluble materials. A lower burn potential than solubles is a plus.

Methylene ureas can be made with varying amounts of WIN. We have used a granular material supplied by O. M. Scott & Sons that had 36% of the total N as WIN. Such a material can be expected to give a good initial response, but also have a greater residual effect than the soluble materials. This product gave turfgrass response similar to that obtained with fertilizers containing 50 and 60% ureaform-N, with the remainder from soluble N sources. Such response more closely followed that from soluble N sources than that from ureaform.

Slow-Release Nitrogen Sources

Slow-release nitrogen sources, which are also called controlled-release, slowly-available, slow-acting, and insoluble, can be classified according to the method by which the nitrogen is released: (1) microbial activity is required for decomposition and release of N from natural

organics and urea-formaldehyde reaction products (ureaform, methylene ureas); (2) low water solubility and a very slow rate of dissolution gives the slow-release characteristic of IBDU; and (3) coatings on soluble N sources act as physical barriers that delay the dissolution of N from sources such as sulfur-coated urea and plastic-coated fertilizers.

Slow-release sources provide a longer duration of N release than the soluble, quick-release sources. They are safe from the standpoint of fertilizer burn (lower salt index), and may be applied at higher rates and with less frequency than soluble sources. The efficiency of some slow-release sources is often low in the first year or two of use. The low efficiency (often expressed as the percentage of the applied N utilized by the plant) and higher cost for N associated with the slow-release sources are reasons that combinations of slow and fast-release N sources are used in many turf fertilizers. In our work at Penn State we have evaluated slow-release sources alone and in combination with soluble sources. The inclusion of some soluble N generally improved turfgrass response in a program of spring plus fall fertilization. A discussion of individual slow-release sources follows:

Natural organics: For the most part, these materials are by-products from the plant and animal processing industries or waste products. Considerable variation exists in the properties of different materials, and even within a given material. The natural organics can be characterized by relatively low N content, the presence of water insoluble nitrogen, and N release intermediate between that of soluble N sources and ureaform. Examples include hoof and horn meal, fish scrap and meal, seed meals (cottonseed, linseed, castor pomace), dried manures, and the two types most commonly associated with turf fertilization: activated sewage sludge and process tankage. Release of N is dependent on microbial activity. Factors influencing release are the chemical composition of the material and environmental conditions that influence microbial activity. Protein sources of N are relatively easily decomposed. Leather, feathers, hair, hoof, and horn contain resistant compounds and are usually treated with steam, and sometimes acid, to hydrolyze the resistant forms of N. Environmental conditions influencing breakdown of natural organics include temperature (conversion of organic-N to NH_4^+-N increases with temperature from 32° to an optimum range of 100-140°F, and conversion of NH_4-N to NO_3-N increases from 32° up to an optimum of 85-95°F); moisture and oxygen (both are usually adequate at field capacity moisture content; however, breakdown of organic materials may be limited in extremely wet or dry soils); soil pH (microbial activity is favored by values near neutral); and available minerals (microbes need these for continued activity).

We have evaluated various activated sewage sludges, including Milorganite, Chicago sludge, and an experimental sludge; Agrinite (formerly process tankage, new process tankage plus sewage sludge), and a paper and pulp mill sludge. All tend to have low recovery of applied nitrogen due to their resistant nature to microbial decomposition. Efficiency increases with continued use. Milorganite has been more efficient than Chicago sludge and Agrinite in our tests.

Ureaform: Ureaform is made by reacting urea with formaldehyde. Ureaform is not a single compound, but is composed primarily of a mixture of straight-chain polymers. Ureaform contains 38% N and about 70% of this N is water insoluble. Ureaform can be divided into three, almost equal fractions based on solubility. Fraction I is soluble in cold water, and contains unreacted urea and the short-chain methylene ureas: methylene diurea and dimethylene triurea. Availability of N in this fraction is similar to that of soluble sources, but is not as quickly available. Fraction II is made up of slow-release, intermediate length polymers (trimethylene tetraurea and tetramethylene pentaurea). It is insoluble in cold water, but soluble in hot water. Fraction III is insoluble in both hot and cold water and is made up of pentamethylene hexaurea and longer chain polymers. It is the most resistant fraction. In a study by Kaempffe and Lunt (from California) the breakdown of these fractions was studied over a period of 26 weeks. After this time period, 4% of fraction I, 25% of fraction II, and 84% of fraction III remained in the soil. The slow decomposition of fractions II and III accounts for the low efficiency of ureaform in the initial years of use. With continued use and build-up of ureaform, recovery of applied N improves.

According to the Association of American Plant Food Control Officials, ureaform should contain at least 35% N, with at least 60% of the total N being water insoluble N (WIN), and the WIN should have an activity index (AI) of at least 40%. The AI represents the amount of cold water insoluble N that is soluble in hot water (commercially available material has an AI of about 55%). Urea-formaldehyde reaction products not falling within these guidelines are referred to by other terms such as methylene urea, methylol urea, and flowable ureaform.

Release of N from ureaform is dependent on microbial activity and the same environmental factors that affect release from natural organics also affect release from ureaform.

Trade names of ureaforms that we have used are Nitroform and Uramite, which is no longer manufactured. By using urea-formaldehyde solutions, ureaform can be made during the manufacture of mixed fertilizers, and some of these products have been included in our tests. Ureaform is available in a granular form and in a powdered form that is suitable for spraying. At Penn State we have not measured significant differences in response to the two sizes. Two applications per year (spring and fall) give good results. Because of low N recovery (efficiency) in the first years of use, it is usually necessary to use higher rates or supplement ureaform with soluble sources in these years. This low recovery and slow response during cool periods support the concept of fertilization with combinations of ureaform and solubles. Two applications per year of a ureaform-soluble combination have given better response than ureaform alone.

If turfgrass response to a normal application of ureaform or natural organic has been delayed due to cool or dry weather, a light application of a soluble can often be used to get response during this period.

Repeated applications of the slow-release source during a period of slow response may be the cause of excessive amounts of N being available when the limiting condition ends.

Organiform: Organiform is a N source made by reacting urea and formaldehyde in the presence of a natural organic N source. Organiform contains about 24 to 25% N, of which about 70% is WIN. Organiform LT is a copolymer of leather tankage and methylene ureas, and Organiform SS is a copolymer of sewage sludge and methylene ureas. Release of N is dependent on microbial activity.

We have found these materials to be slower in release and less efficient than Milorganite and Nitroform. Response has improved with continued use. A combination of 50% organiform N and 50% soluble N greatly exceeded the performance obtained with straight Organiform.

Other urea-formaldehyde reaction products: Although we often think of slow-release N when we hear the term urea-formaldehyde, there are some urea-formaldehyde reaction products that tend to be more quick-release than slow-release. The ratio of urea to formaldehyde used during manufacture affects the amount of WIN in the fertilizer. Ureaform is made using a ratio of about 1.3:1. Other N sources are made using wider ratios (more urea), and the result is lower amounts of WIN. I am not aware of any formal or informal rules that dictate when the term 'slow-release' is justified for an N source with a given amount of WIN. Certainly, confusion can arise when 'slow-release' is used with a material that has less of the total N as WIN than mixed fertilizers containing combinations of slow-release and soluble N such as 50% IBDU or Ureaform N and 50% soluble source N. The characteristics of three urea-formaldehyde reaction products (methylene ureas, methylol urea, and flowable ureaform) were given under the 'Quick-Release N Source' heading. Of these three, the slowest-release of N would occur with methylene ureas.

IBDU: IBDU (isobutylidene diurea) is made by reacting isobutyraldehyde and urea. It contains 31% N, with 90% of the total N being water insoluble in the coarse (0.7 to 2.5 mm) product and 85% being water insoluble in the fine (0.5 to 1.0 mm) product. Release is slow due to low solubility; but once in solution, IBDU is hydrolyzed and releases available nitrogen. Particle size has a large effect on release of N, with smaller particles releasing more quickly. Release also increases with increased soil water content. Release is also affected to some degree by temperature and pH. Hydrolysis is faster under acidic conditions. The rate of release also increases with temperature, but low temperature does not affect IBDU as much as it does those sources dependent on microbial activity for release.

Our work with IBDU was started in 1966. We have observed a 3 to 4 week delay before obtaining response from IBDU applications on Kentucky bluegrass, but not after applications to an aerified and topdressed green. Probably the close contact with wet soil and more liberal irrigation practices enhanced release on the putting green. If the delay in response

is considered objectionable, a soluble N source can be used to supplement the IBDU. We have observed early spring greening with IBDU, and N recovery from IBDU exceeded that from ureaform during the initial years of use. Two applications (spring and fall) have given good results on both bentgrass and bluegrass. On bluegrass we found no advantage to three applications. A single spring application had a longer residual effect than a single fall application. We have obtained a quicker response and greater N recovery from fine than coarse IBDU. Compared to 100% IBDU, a 50/50 combination of IBDU and soluble N improved response following spring and fall applications and gave a higher recovery of applied N; however, residual response in the summer was poorer.

Plastic-coated fertilizer: Sierra Chemical Company uses the Osmocote process to produce plastic-coated fertilizers. In this process, plastic coatings (also called resin or polymeric coatings) are applied to soluble sources of N, P, and K. For release to occur, water passes through the coating and dissolves the fertilizer salt. This causes pressure that swells the capsule, and the dissolved salts diffuse out through enlarged pores in the coating. Different coating thicknesses are used to obtain different release patterns. The thicker the coating, the slower the release. Release increases with increased temperature. If coatings are ruptured or cracked by mechanical damage or due to prolonged, excessive drying, release rate increases. The release rate is not significantly influenced by soil moisture levels (from wilting point to field capacity), volume of water applied, soil pH, or microbial activity.

The number of applications required is dependent on the formulation. We used a six-month formulation on a putting green and performance fell short of 6 months. At lower temperatures the same formulation would be expected to last longer. We applied the fertilizer after aerification on the green to minimize mower damage to particles. After a single application of 6 lb N/1000 ft^2 on fairway bentgrass, we observed turf damage when coated sources (both plastic- and sulfur-coated) were damaged by tractor and mower traffic.

Sulfur-coated urea: Sulfur-coated urea (SCU) is made by spraying preheated urea prills or granules with molten sulfur. A sealant, such as wax or a mixture of oil and polyethylene, is then applied to seal pores and imperfections in the sulfur coating. Nitrogen content is usually in the range of 32 to 38% and is dependent on coating thickness (weight). Increasing the thickness decreases the nitrogen content. Smaller particles of urea have a greater surface area than larger particles; thus more sulfur is needed to obtain a given coating thickness on finer particles. This increased sulfur requirement decreases the percent nitrogen in the final product. Nitrogen is released from SCU by degradation of the coating and/or diffusion of soluble nitrogen through pores in the coating. Release rate increases as coating thickness decreases and as temperature increases. The formation of ferrous sulfide on SCU under water-logged conditions slows release of N. As with the plastic coated materials, breakage of the coating increases release. The 7-day dissolution rate in water (laboratory determination) is commonly used to characterize

different formulations of SCU. Commercial products for turf have dissolution rates in the range of 25 to 35%. These values can be used to roughly estimate the amount of N that will be readily available. The remainder will have some degree of slow release. A much wider range of dissolution rates has been used in experimental SCU. We found a product with an 11% dissolution rate to be somewhat slow for our conditions, but it was quite satisfactory in tests conducted in the warmer climate of Alabama. Another experimental SCU had a dissolution rate of 83% and gave results similar to those obtained from soluble sources. Although this material was a SCU, it could hardly be called slow-release. It would, however, offer less potential for fertilizer burn than straight urea.

Particles within an SCU product are not identical. If they were, one might expect all of them to release N at the same time. Instead, the imperfectly coated particles supply the initial N; then those in which the sealant has covered imperfections release N; and the greatest delay in release occurs with the thicker coated and more perfectly coated particles having no imperfections. Once release begins from a given particle, it is quite rapid. Thus, the slow-release property of SCU comes from the variability in coatings among the individual particles.

The Tennessee Valley Authority (TVA) has done considerable developmental and agronomic work with SCU. We have evaluated commercially available SCU produced by TVA, Canadian Industries Ltd. (CIL), and Ag Industries Manufacturing Corp. (AIM) as well as various experimental formulations. SCU has given good response from two applications per year on Kentucky bluegrass turf, and N recovery has equalled that of soluble N sources. Combinations of SCU and soluble N sources did not give improvement over the performance of SCU alone. Some of the finer SCU materials are suggested for use on putting greens. Breakage could be a problem under these conditions. As much as 20% of applied SCU was picked up at a mowing height of 3/16 inch in a study conducted in England. Mowing without grass catchers would prevent such removal, but breakage could still occur. High rates should be avoided where breakage due to mowing or traffic could occur.

Most of our results with slow-release fertilizers have been published in scientific journals. Some of our more recent findings appeared in trade magazines and can be read in the May/June 1981 issue of American LawnApplicator and in the November 1981 issue of Grounds Maintenance Tenth Annual Golf Course Manual.

Lawn Fertilization Research Results

In late spring of 1980 we began an evaluation of thirty lawn fertilization programs on Kentucky bluegrass. The programs included a wide range of commercial and experimental N sources applied at various rates and timings. The seasonal rate of N for all treatments was 4 lb N/1000 ft^2.

Materials included urea, methylol urea, methylene urea, liquid methylene ureas, flowable ureaform, Folian (a water soluble 12-4-4), three sulfur-coated ureas, ureaform, IBDU, Scott's 31-3-10 (6.7 WIN), and Agway's 20-5-10 (8.0 WIN). In some cases, different materials were used on different application dates within a treatment. Timings were 1 lb N/1000 ft^2 in early spring, late spring, summer and fall; late spring, summer, and fall applications of 1.25, 1.25, and 1.50 or 1.0, 1.0, and 2.0 lb N/1000 ft^2, respectively; and 2 lb N/1000 ft^2 in late spring and late summer.

By the end of 1981 we had concluded that 4 lb N was giving good quality turf regardless of our sources and timings. Significant differences did occur among treatments, but, in general, all plots looked good. The following are some observations from this test.

Comparisons and observations:

Urea (1+1+1+1) vs Folian (1+1+1+1): Almost identical response except in late fall of 1980 when Folian gave a poorer response.

Urea (1+1+1+1) vs Urea + F-UF + F-UF + Urea (1+1+1+1): Similar response, but urea gave slightly greater peaks in response and the flowable UF gave a hint of more residual effect.

Urea (1+1+1+1) vs Urea + MO + MO + Urea (1+1+1+1): Similar response, but lower peaks and more residual when methylol urea was used.

Urea (1+1+1+1) vs 31-3-10 (1+1+1+1): Similar, but 31-3-10 tapered off slightly faster in the summer of 1981.

Urea (1+1+1+1) vs AIM SCU (1+1+1+1): Similar, but urea tended to drop lower between peaks of response.

Urea (1+1+1+1) vs Urea (1+1+2): Slightly earlier summer application with 1+1+1+1 gave better appearance in 1980. Better fall color with 2 lb N, but by 1981 response was very similar.

Urea (1+1+2) vs 31-3-10 (1+1+2): Similar, but 31-3-10 held up better in the summer of 1980.

Urea (1+1+2) vs F-UF+F-UF+Urea (1+1+2): Use of flowable UF gave slightly better appearance in late summer and fall of 1980, but in 1981 the urea treatment was somewhat better.

Urea (1+1+2) vs MO+MO+Urea (1+1+2): Similar in 1980, but urea gave more response in 1981.

Urea (1+1+2) vs AIM SCU (1+1+2): Similar except in late summer of 1981 when urea looked better.

31-3-10 (1+1+1+1) vs 31-3-10 (1+1+2): Tendency for better color with 1+1+2.

AIM SCU (1+1+1+1) vs AIM SCU (1+1+2): Not many differences.

AIM SCU (1+1+1+1) vs AIM SCU (2+2): The 2+2 treatment had better spring and fall color and poorer summer color in 1980. Essentially the same response in 1981.

Urea (1+1+1+1) vs 20-5-10 (2+2): The 20-5-10 held color longer after initial application in 1980. Summer application of urea in 1980 gave better color for that treatment. In 1981, response was better with urea treatment.

Urea (1+1+2) vs 20-5-10 (2+2): Better appearance with urea treatment for much of the growing season.

EQUIPMENT FOR LAWN CARE

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The professional lawn care industry was founded and developed primarily during the late 1960's and 1970's. Local landscape companies and individuals were involved in lawn maintenance for many years before that, but often on a personal gardener or total maintenance basis. The concept of relatively inexpensive fertilization and pest control of lawns for large numbers of urban residencts by commercial interests rather than "do-it-yourselfers" is a phenomena of the last two decades. During this time period the professional lawn service industry has grown very rapidly to where an estimated 7.7 million residential lawns were treated in 1980, according to one estimate(1).

The growth of the professional lawn care service has created a need for specialized equipment for the industry. In the early years most of the equipment was developed by individual companies to meet the requirements of their own operations. More recently a number of equipment companies have put together spray units and specialized equipment to service this industry. Improved application of both liquid and granular products has resulted from this improved technology.

A number of characteristics should be considered when improving or developing equipment for the professional lawn care industry:

1. Accuracy
2. Versatility
3. Durability
4. Capacity
5. Weight
6. Pressure
7. Adjustment/Calibration
8. Cost/Efficiency

Accuracy of spreaders and sprayers is important not only for the quality of application, but also for the amount of product applied. Accuracy directly affects both agronomic performance and lawn quality as well as the financial balance sheet. Any equipment modification or development must, therefore, maintain or improve upon accuracy of product distribution both in total amount and uniformity of distribution across the swath width.

Spreaders and sprayers should be versatile and have the capability for the operator to vary the pattern or swath width for easy application and maneuverability in odd-shaped or tight spots. Some of the equipment should be capable of performing more than one job and be capable of doing trim work and making neat edges.

Nothing is worse than having equipment constantly break down resulting in costly repairs and downtime. Equipment must be sufficiently durable so that a minimum of preventative maintenance will keep units operating smoothly and production in progress. Minimal downtime and replacement parts can have a significant impact on profitability, attitudes, and customer service.

The equipment used should have sufficient capacity of product to treat an entire lawn and also provide sufficient carrying capacity of material for an entire day's production. There may be exceptions such as large commercial acreages, but they should not occur frequently.

While most equipment has to be well built to withstand the rigors of daily production, it should still be lightweight and easy to use. Extra weight simply adds to operator fatigue and reduced performance and accuracy over an extended period of time.

Liquid application equipment should be designed to deliver the proper quantity of materials at a reasonably low pressure to reduce drift potential and wear on the quipment. It must deliver the precise quantity at a constant pressure without pressure drop or surging.

Equipment designed for easy and accurate adjustment is certainly convenient and more likely to be calibrated on a regular basis by production personnel. Equipment that is hard to calibrate, adjust, or maintain should be reengineered to make it possible for production personnel to do it on a regular basis and requiring a minimum of time.

Finally, cost of equipment is often somewhat fixed by engineering, manufacturing, and raw material costs. However, newly designed equipment must meet the needs of a rapidly developing industry and at a price affordable by the industry.

In addition to the basic spray and spread equipment, applicator personnel should be equipped with inspection or survey tools to do their job properly. A durable, accurate measuing device is imperative to (a) determine lawn size for accurate product use, (b) be fair to the customer, and (c) enhance industry professionalism. A soil probe is invaluable for taking soil samples to determine nutrient requirements, soil type, compaction problems, and thatch accumulation. A small magnification lens and plant identification keys may be very helpful to a lawn specialist in identifying new plant material or pests and to enhance customer respect by providing professional expertise and quality service. Additional field manuals and other software necessary or desirable for your particular mode of operation should be provided.

The final area addressed in this particular discussion of the topic on equipment will be recent innovations or possible directions of development that would be helpful. One development will likely be increased use of split tanks and/or double pumping systems. This would allow carrying of two or more mixes for different applications to meet different needs. At least one available system allows for on-site mixing of various pesticides for specialized treatment according to specific lawn requirements. Injection of individual products at the spray gun or hose reel would also

allow specialized lawn treatments and an improvement to the total concept of professional lawn care. Any efficient combination of equipment that allows for specialized product treatments or spot treatment to localized areas will probably be of increased importance in future years to the lawn care industry.

It is likely more fiberglass tanks and components will be utilized in the future because of its strength, light weight, and resistance to corrosion. There is a need for methods of reducing equipment corrosion where iron chelates are used in fertilizer programs. Development of techniques to more accurately target applications and reduce spray drift would improve efficacy and safety considerations. Spray drift control is particularly crucial in relation to environmental pollution and the number of ornamental plants in the home landscape. Specialized equipment to accurately apply fertilizers and pesticiees to large commercial acreages utilizing wide swaths and low volumes would also seem to be an area for future improvements. Closed systems utilizing extremely accurate metering devices for low volume pesticide fills would improve applicator safety, eliminate reading and measuring errors, and increase efficiency. No doubt there are many other specialized considerations for improved equipment that could be added to this list.

The professional lawn care industry has benefited from greatly improved equipment capabilities in the last decade. While not an exhaustive treatment, the above comments are intended to outline some possible areas of continued improvement in fertilizer and pesticide applications.

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1. McNamara, Tom. 1981. "What is Upper-Limit of the Lawn Care Industry?" (President, Nuventures Consultants) Lawn Care Industry 5(4):1,34-36.

NEEDS OF THE LAWN CARE INDUSTRY

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My remarks on this topic will be brief. I want to identify and explain what I consider to be the five major needs of the lawn care industry here in North Carolina. These needs are:

1. We need a more substantial lawn care industry iteself.
2. We need to educate consumers to the existence and benefits of professional lawn care.
3. We need to establish and maintain an image of professionalism.
4. We need to become involved in politics--at least to the extent that laws and bureaucratic regulation affects us.
5. We need to police ourselves by adhering to high standards and protecting the industry.

Now, let's look at each in turn.

We need a more substantial lawn care industry--you might be wondering why I'd say this. In this state I would estimate that we are now providing service to less than 10% of the potential lawn care customers. I also believe that in order to reach the other 90%, we need additional lawn care companies. Those of us here need to work harder, of course, but I don't see this state becoming a major lawn care market without increased competition. When I took over managing our company's efforts in the Triad area in 1974, I was enthusiastic about getting a crack at virgin territory. I've since come to the conclusion that dramatic growth in our area was stifled in the early years by lack of competition.

We need to educate consumers to the existence and benefits of professional lawn care. There are many, I would say the majority of the owners of single family dwellings in this state, who don't make the immediate association of what we do when they hear your company's name, or mine. In areas of the country of greater lawn care market saturation, you say ChemLawn, Leisure Lawn, Rollins, Lawn Groomer, etc. and the man on the street knows that these guys do. I maintain that in this state we are still in the stage of saying to the homeowner, "Look, we are here," and "Give us a try". And further, that we are not so much competing against ourselves as we are competing against consumer ignorance to the existence of professional lawn care in North Carolina.

Now, let's look at our image. I've just said that there are many who are not completely aware of what we are all about. So, we must endeavor to present a good image. If we expect to be looked upon as professionals, we must be conscious of our image. Our companies should be represented by knowledgeable personnel, our trucks should be clean and sharp, and our lawn care programs have to produce results. In short, we must set high standards for ourselves and live up to them.

Our fourth need--involvement in politics. What does politics have to do with maintaining turfgrass? Two things come to mind immediately. First, we all depend on research from the fine people at NC State, and we need to lobby for continued funding for turfgrass research. Second, we need to be prepared to present and defend the use of pesticides essential to our industry in our governing bodies.

Finally, we need to be our own policemen, protecting ourselves from anyone who might cause damage to the image of professional lawn care. We should all have contact with local Better Business Bureaus, if not active membership. Be on the lookout for a fly-by-night operation and report it. Become members of our Professional Lawn Care Association of America. Get to know each other better, to be able to jointly protect our image and thus our livelihoods.

CUSTOMER RELATIONS

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If you are in the lawn care business and dealing with the homeowner, customer relations are as important as any aspect of your business. You could have an agronomically sound program, a marketing plan that makes your phone ring off the wall, and the best equipment fleet, but if you are not prepared to establish and maintain a satisfying relationship with the customer, success will be elusive.

My own personal experience in the chemical lawn care industry over the last nine years has taught me that leaving a customer with an unresolved problem, whether real or imaginary, can haunt you. I believe that the customer is more likely to communicate an unfavorable experience than he is to share a good experience. That is why we at Lawn Medic spend time, money, and a great deal of effort on customer relations. I'll share with you some of the specific methods we use, but first let's talk about a few general concepts of how customer relations work for us.

Customer relations, whether they turn out to be good or bad, have to start somewhere. It all starts with their first awareness of the company, yours or mine. It might be a mailer, newspaper ad, a referral from another customer, or from another source. If you attempt to create customer awareness through advertising you must take into consideration that if you create unrealistic expectations in the consumer's mind, you will have to deal with those expectations. Once they are aware of you, the next step is usually the contact from the potential customer. A prompt, courteous reply is a positive step toward good customer relations. When an estimate is given, you have one of the most important opportunities to establish an understanding of exactly what you are going to do for this homeowner's property, what you are not going to do, and what kind of cost you are talking about. It is absolutely necessary that verbal or written communication be clear and precise. Remember that unrealistic expectations not dealt with at this point will be more difficult to handle as time passes. For example, if you explain to a homeowner in the spring that dormancy is a natural occurrence in fescue lawns during dry periods of July and August, you will avoid complaints later, and the customer will be satisfied. If you wait until July or August to explain, your reasons are going to sound more like excuses.

When it comes to customer relations, I've found we have three basic types of customers, and I have a name for each type.

The first one I will call Mr. Grub. This customer calls with a specific problem. We are able to solve that particular problem, his lawn improves, he's satisfied, and as long as we continue to provide timely applications, we will have a good relationship--we go about taking care of his lawn, he sends in his payments, no problems. He makes up 75% of our customer lists.

The second type we'll call Mr. Weed. This guy calls with a problem that takes a little more effort to satisfy. He seems to take a little more time examining the results of our work than Mr. Grub. He'll find weeds with his magnifying glass just as they are germinating. And, of course, he runs right to the phone to call his lawn care company. The urgency in his voice makes it seem that his house is burning down rather than a few patches of chickweed popping up. This type takes a little more effort to satisfy. Of course, you are going to have to make a service call, blow those outrageous weeds away, but what this type is looking for more than weed control is to be assured that you care about his lawn. This is where a few minutes of conversation or a hand-written note along with an appropriate lawn bulletin on the problem can win him over. Again, the customer has been satisfied. Your score card for customer relations is 2 and 0.

The third type I'll call Mr. Crabgrass. Now, old crabbie is a tough character. I sometimes wonder if this type doesn't hire a lawn service just to have someone to harrass. He strains your customer relations to the limit. Of course, he calls, you respond, but after it seems you are doing all that can be done and you've made every possible effort to communicate, he just keeps getting crabbier and crabbier. This type of customer frequently has one of the best lawns on the street to start with. After all reasonable means of satisfying this type fail to work, you have only one alternative -- you fire him! Of course, this must be done with diplomacy. Luckily this type only makes up about 1% of the customer list if good customer relations have been established to start with.

CUSTOMER RELATIONS

James S. (Jim) Mitchell
Rollins Lawn Care
Charlotte, NC

SELLING TECHNIQUES

The solid bond with any company/customer relationship starts with the initial contact. You must sell yourself first. Remember, you are dealing with the client's home and property, one of his most cherished and valuable possessions. Find the attractive things and comment on them. Treat him and his property with respect. By doing this you will in turn gain his respect.

Build a positive image with positive statements about your Company (be it large or small). Make statements to the quality of your service, all positive. Never tear down your competition. In some cases (where competitors are incompetent) it is easy to do, but it won't win points. Keep coming back to your company's strong points. Compliment your competitors -- your prospect will respect you for it, and realize that you are not afraid of competition, but thrive on it.

Be more of an advisor (turf care) than a pushy salesman. You will gain the respect of the customer and sell more accounts by first dealing with the needs of the turf in general and how your program can meet these needs. Take a long view of the prospect's turf area and present a thorough breakdown and analysis of his needs, for an example: a) the cause of his problems, b) the immediate steps he must take, c) the immediate steps you must take, d) the changes he may expect (with his cooperation) during various cycles of the program, and e) the long term general cultural requirements of a healthy turf. Undersell your program, keep your prospect's expectations lower than what you think you can deliver. Be totally honest with every prospect. Give an honest objective analysis (and measurement), do not bend the truth for a sale.

SERVICE AFTER THE SALE

Once you have gained the customer's respect, to him you are a professional in turf care. The customer will look to you and view you with the same professional respect he does his accountant, his doctor, and his attorney. To keep respect you must earn it.

Follow up on all committments. If you say you will do something -- do it! If you say you will call back -- be sure you do so. If you promise service for a certain day -- be there or call to explain why you can't be. Respond to inquiries promptly. Make sure each customer's problem is being handled with sincere concern and compassion.

Listen to the customer. No matter how "simple" or "elementary" his inquiry may seem, listen. Make absolute certain the answer to his questions or the solution to his problem is correct. If you are unsure of a diagnosis,

such as a disease or grub problem, engage another competent authority. The customer will respect your honest and humility. Take full responsibility for problems when an error has been made. Correct the problem promptly and to the customer's satisfaction.

Make absolutely certain the customer is getting everything he is paying for. Never compromise quality with the idea of cutting costs. Establish and always adhere to a fair pricing schedule in your market. Notify the customer well in advance in the event of price changes, in order for him to plan and budget his personal finances. Strict adherence to quality and fair marketing and pricing trends, will build (you and your organization) a solid reputation in the marketplace and respect in the (Turf Care) Industry.

SUMMARY

Always remember you are selling a service. The prospects are hungry for friendly, honest and competent service. Promise only what you (and your organization) can deliver, and be very sure you always deliver more than you promise.

CUSTOMER RELATIONS

Larry Sheldon
Classic Landscapes
Raleigh, NC

Our business is primarily landscape maintenance service rather than lawn spray applicators. We visit our client's property once each week. In our relations with our clients, we stress several things: 1. Organization. 2. Dependability. 3. Communication. All three of these, when combined, give you a very professional appearance.

Organization - All of our working foremen know who our client contact is, and they visit him at least twice per month. They are also individuals who are trained in the Agronomy or Horticulture fields. They are all well-versed on the specifications of the contract.

Dependability - How long does it take you to respond to a customer complaint or request for help? The faster the better. Remember, you are there only to serve your client the best way possible. Schedule your work well and stay on schedule.

Communication - Everyone in the management area of our company from the foreman to the operations manager to me, visits or talks with our clients at least monthly. We feel like good communications between our organization and our clients is essential. Also, communication within our organization is essential. In order for us to provide good service to our clients, everyone in our organization needs to be informed.

NITROGEN FERTILIZATION FOR MAINTENANCE OF COOL AND WARM SEASON TURFGRASSES

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The regular maintenance of turfgrasses is comparatively simple in areas where soil conditions are favorable and adapted grasses are present. Since most of the Piedmont of North Carolina is in the "transition zone" for turfgrass adaptation, and the soil conditions are less than favorable, a good management systems calls for certain standard practices, carried out to take advantage of the normal growth cycle of the grasses. When given the opportunity, grasses will improve soil conditions through the yearly cycle of root growth. New roots replace old ones yearly in most species, and there is a continuous reproduction of new stems and shoots during the growing season, thus giving perennial grasses the potential for regaining vigor when unfavorable conditions are corrected.

The growth of roots and shoots of a turfgrass plant is closely interrelated and strongly influenced by the environment. The roots depend on the shoots as the source of carbohydrates, while the shoots are largely dependent on the root system for the uptake of water and nutrients. Both shoots and roots require carbohydrates for growth, but since the shoots are closer to the photosynthetic activity, they assume priority in utilization when the supply of CHO is less than required for both. Thus, shoot growth may occur at the expense of root growth. The factors that stimulate shoot growth and adversely affect root growth are as follows:

a. Temperatures above optimum for root growth.
b. Close cutting.
c. Excessive nitrogen.
d. Low light intensities.

From an environmental standpoint, factors that can restrict rooting include:

a. Excessively high soil temperatures.
b. Acidic soils.
c. Lack of soil oxygen caused by compaction or waterlogged soils.
d. Presence of toxic pesticides or salts.

Cultural factors that can cause a reduction in the root system include:

a. Cutting at a low height or excessive frequency.
b. Excessive nitrogen level.
c. Potassium deficiency.
d. Excessive thatch accumulation.

Since the root system is so vital to the production of top quality turf, a good management system, particularly fertilization, should be directed to the production of as good a root system as possible. The following temperatures for cool season grasses should direct us to the proper timing of nitrogen fertilization.

	Minimum	Optimum
Root growth	33° F	60° F
Shoot growth	40° F	80° F

This table shows that the root system of cool season grasses are growing any time the soil is above freezing, and thus should be encouraged by the proper timing of nitrogen fertilization. Hardy cool season grasses in the Piedmont of North Carolina are adapted to a fall-winter fertility program which results in improved color retention, shoot density, and root growth plus adequate spring and summer response. Late fall and winter nitrogen fertilization stimulates winter chlorophyll synthesis and photosynthesis at temperatures just above freezing without a comparable increase in respiration, carbohydrate reserve utilization, and shoot growth. An adequate spring response in terms of turfgrass quality and color is also achieved without over-stimulating shoot growth that causes an increased mowing frequency. The following table gives the suggested percent of nitrogen fertilization by seasons that will accomplish the above:

	Fall	Winter	Spring	Summer
Cool season lawn grasses	45	45	10	0
Bentgrass on greens	40	30	20	10

Most home owners will fertilize their tall fescue or bluegrass lawns in the spring. If this is the major application, they are about six months too late. This is the general "farm pasture" practice, where a lot of top growth is desired. With turf, the top growth that is left after mowing is the important part, not what or how much is taken off. Very few prizes are given for the lawn that produces the most clippings. Stimulation of the top growth of cool season grasses in the spring are probably the major cause of summer loss of cool season grasses.

The advantages of fall-winter nitrogen fertilization on cool season grasses are as follows:

a. Greener in winter.
b. Less spring mowing.
c. Better root system.
d. Fewer weeds in summer.
e. Less heat damage.
f. Reduced irrigation needs.
g. Less disease problems.

A schedule for nitrogen application on cool season lawn grasses could be as follows:

One application	--	Mid-October
Two applications	--	Late September and late October
Three applications	--	Mid-September, late October, mid-February
Four applications	--	Mid-September, late October, mid-February, mid-May

Note that the above schedule does not call for any nitrogen when the tops or shoots are in the flush of growth. If a good root system is produced by fertilizing in the fall and winter, the shoots are going to be produced in sufficient quantity and quality without a serious deterioration of the root system.

Fertilization of warm season grasses are almost the opposite timing as for cool season grasses. The following temperatures for warm season grasses will indicate the proper timing of nitrogen fertilization:

	Minimum	Optimum
Root growth	60° F	80° F
Shoot growth	55° F	90° F

The minimum temperatures for root and shoot growth are quite different than those for cool season grasses. The roots of the warm season grasses start after the top growth, which is opposite that of the cool season grasses. Research by DiPaola and Beard indicate that the root systems of bermudagrass and St. Augustinegrass almost completely die within one week after the initial green-up of the shoots, and usually are not able to support much shoot growth for several weeks. This means that the spring nitrogen fertilization should be delayed about two weeks after the initial green-up of the shoots is observed, along with any herbicide treatments. The following table gives the suggested percent of nitrogen fertilization by seasons:

	Fall	Winter	Spring	Summer
Warm season grasses not overseeded	10*	0	35	55
Warm season grasses overseeded	15	15	35	35

*The 10% nitrogen in the fall for non-overseeded warm season grasses such as football fields, fairways, etc., should be in early September. Later nitrogen applications would promote excessive growth when the grasses should be slowing down and becoming cold-acclimated.

The following table are guides for the nitrogen fertilization of turfgrasses:

Intended use	Requirements	
	Cool season	Warm season
Golf greens	4-12 lb/m	6-16 lb/m
Tees and athletic fields	3-6 lb/m	6-12 lb/m
Home lawns	2-4 lb/m	1-6 lb/m
Large general turf areas (fairways, parks, cemeteries, industrial grounds, playgrounds)	60-120 lb/A	40-160 lb/A

Relative Nitrogen Fertility Response Range of Turfgrasses

Nitrogen fertility level	Pounds N/m per month*	Turfgrass species	Pounds N/m per year
Very low	0.0-0.4	Bahiagrass	1-3
		Centipedegrass	1-3
Low	0.2-0.6	Carpetgrass	1-3
		Red fescue	1-3
Medium	0.4-1.0	Zoysiagrass	2-4
		Tall fescue	2-4
		Perennial ryegrass	2-4
		Ky bluegrass	2-4
		Poa trivialis	2-4
		St. Augustinegrass	3-5
High	0.5-1.5	Creeping bentgrass	4-12
		Bermudagrass	6-18

* During months of growth.

STATUS OF 2,4-D ON TURF

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I can remember as a youth spraying 2,4-D and watching dandelions curl up. It has been of great benefit in turf weed management for over three decades and will continue to be so. Also, 2,4-D has proven widely useful on farms around the world for selective control of broadleaf weeds in cereal grains.

Based on results of EPA's review of the available information on the potential health effects of 2,4-D, the Agency has concluded that: information from scientifically valid studies does not indicate that the continued use of 2,4-D poses an imminent hazard or unreasonable adverse effect when used according to label precautions and directions for use. I would like to emphasize again, when used according to label precautions and direction for use. This means 1) selecting the proper rate for the broadleaf weed or weeds present taking into account the tolerance of the turfgrass to 2,4-D, 2) using non-volatile forms of 2,4-D, such as 2,4-D amine, 3) wearing protective clothing while mixing and applying 2,4-D, 4) controlling spray drift to desirable trees, shrubs, and flowers, and 5) avoiding spills which could kill desired vegetation or contaminate water.

Certainly the objective of the lawn care industry is good turf relatively free of weeds. Your customers also desire sound information about the safety of products used for the control of weeds as well as other pests. You can assure them that all pest control products sold today, and the use directions and precautions on the label, have been approved by EPA based on thoroughly documented research. If you follow the labels, which include the suggestions in the previous paragraph, your customers, your employees, and the public or environment will not be adversely affected by the application of 2,4-D.

For you and your customers who are interested in facts, the following will be helpful in answering questions about the safety of 2,4-D. This information was summarized from "Public Concerns About the Herbicide 2,4-D" by Dr. Wendell R. Mullison of Dow Chemical Company.

1. Widescale tests have established 2,4-D to have a low to moderate level of acute toxicity when administered to laboratory animals, orally or by inhalation, or when placed on skin or in eyes. The compound is rapidly eliminated from the mammalian body, including humans and no significant accumulation occurs. It is rapidly excreted in the urine of humans.

2. Extensive research with rats and dogs on carcinogenicity, reproductive physiology and on possible genetic or birth defects show 2,4-D to have no potential for chronic toxicity at doses far in excess of any likely human exposure.

3. Extensive toxicological investigations over a period of many years, together with widescale human experience on the part of millions of spray applicators have shown that 2,4-D herbicide products present no practical health hazard associated with their application on farms or golf courses or other turf areas. Neither trace ingestion or skin contact associated with ordinary spray operations can result in sufficient uptake by the body to have an effect. Contact of concentrated materials with skin and particularly with eyes can cause irritation if not promptly and thoroughly washed off. Contact of diluted sprays except to eyes will generally not cause any injury although prudence would indicate that it should be washed off.

"2,4-D is not metabolized in the human body, but rather passes through unchanged after a large dose is ingested," says a recent U. S. Forest Service study. Estimates based on the study indicate that a 175-pound worker who applied 2,4-D 30 days each year for 30 years will have less than one gram of the herbicide enter his body, according to Ralph G. Nash, a USDA chemist who is a specialist in analyzing pesticide residues. The amount of 2,4-D excreted is essentially equal to the amount of the herbicide absorbed. This study focused on wheat field ground applicators in North Dakota and aerial applicators in Washington state. One university toxicologist has claimed a person applying 2,4-D is 20 times safer than a person drinking one cup of coffee.

4. Recent claims that individuals have been made ill by incidental exposure while spraying 2,4-D appear to have no foundation, according to authorities who have conducted research on the toxicity of 2,4-D. There have been a few purported "scientific reviews" of toxicological data in which the authors contend that the researchers obtaining these data were in error in their conclusions and that the compound does present a hazard. These reviews have, in turn, been studied by leading toxicologists and found to present unwarranted conclusions. The vast majority of toxicologists believe that the evidence indicates a high level of safety on the part of this compound to humans and wildlife.

5. Recent reinvestigations by toxicologists and chemists confirm earlier data indicating that there is no toxic hazard from solvents used in formulating 2,4-D products nor in the traces of impurities that may be present.

6. 2,4-D does not contain TCDD, a toxic impurity found in minute quantities in 2,4,5-T and also sometimes present in the environment as a result of combustion of various fuels. The only impurities that have ever been found in 2,4-D belonging to the dioxin group of compounds of which TCDD is a member are relatively low in mammalian toxicity.

The following list of weeds susceptible to 2,4-D, illustrates the importance of 2,4-D to the lawn care industry in North Carolina. Weeds susceptible to 2,4-D include: bittercress, black medic, buttercups, carpetweed, cranesbill, dandelion, dichondra, wild garlic, hawkweed, healall, plantains and yellow rocket.

I believe that 2,4-D will continue to be an effective part of weed management in turf. Its continued use in turf will depend on the attention the lawn care industry gives to safe application techniques and their support of the scientific information indicating that when 2,4-D is used properly it does not present an imminent hazard or unreasonable adverse effect. In closing, I would like to reemphasize -- follow all the safety rules and precautions mentioned on the label. They should be taken seriously. They are for you, your crew, your customer and the environment.

JOB COST ESTIMATES

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Estimating job costs is an important managerial function in all ornamental businesses. Although there may be individual satisfaction received from working with plants, a business must be able to generate a profit for its long term survival. Each business must be operated with the goal of realizing a profit. The preparation of job cost estimates will have a major impact on achieving the profit goals that have been established by the manager. Managers must know the costs associated with the total business operation if they are to bid knowledgeably on contracts. Omission of one or more of the cost components in a job estimate will result in the profit goal not being fully realized. In some cases this omission of costs has resulted in negative returns to the business operation. Therefore, the major purpose of this paper is to identify the cost components of the job estimate and to illustrate how these individual components are used to calculate the total job cost estimate. The total job cost estimate will then be used to compute a target bid price, based on a specified profit goal, that can be used when bidding on a new contract.

Another important consideration to many ornamental business managers is the demand on their time. Although the preparation of job cost estimates can be a laborious and time consuming task, the process can be expedited by adopting systematic procedures and policies. It is hoped that the forms or worksheets presented in this paper will serve as a guide that will allow the manager to develop his own systematic procedure for estimating job costs.

The components in estimating job costs may be classified as:

1. Machinery costs
2. Labor costs
3. Materials costs
4. Overhead costs

To arrive at machinery costs for the job estimate, the manager must first estimate the annual machine cost for each machine that will be used for the proposed job. The following example illustrates a worksheet that can be used in estimating annual machine costs. This form provides a step by step procedure that leads from the purchase price to the total cost per year and the total cost per unit of use. Most of the data are known or require the manager to make reasonable estimates.

ESTIMATE OF ANNUAL MACHINE COST

3/4 Ton Van
(machine)

Item:		Amount
1.	Purchase price	$ 11,000
2.	Salvage value	$ 5,000
3.	Average value (purchase price plus salvage value divided by two)	$ 8,000
4.	Estimated years of life	3
5.	Units of estimated annual use (hours, miles, etc.)	20,000 miles
	Fixed or Ownership Costs:	
6.	Depreciation[1] (Purchase price minus salvage value divided by years of life)	$ 2,000
7.	Interest: (average value $8,000 x interest rate 15%)	$ 1,200
8.	Taxes (average value $8,000 x tax rate 1.5%)	$ 120
9.	Insurance (average value $8,000 x insurance rate 3.5%)	$ 280
10.	License and title	$ 42.84
11.	Total fixed costs (add lines 6 through 10)	$ 3,642.84
12.	Fixed cost per unit (line 11 ÷ line 5)	$ 0.18/mile
	Variable or Operating Costs:	
13.	Fuel[2] (.07 gal./ mile/unit x 20,000 no. units x $1.29 /gal.)	$ 1,806.00
14.	Oil, grease, anti-freeze	$ 130.00
15.	Repairs (including service labor), tires, etc.	$ 400.00
16.	Total variable costs (add lines 13 through 15)	$ 2,336.00
17.	Variable cost per unit (line 16 ÷ line 5)	$ 0.12/mile
18.	TOTAL ANNUAL MACHINE COST (line 11 + line 16)	$ 5,978.84
19.	TOTAL COST PER UNIT (line 18 ÷ line 5)	$ 0.30/mile

[1] Depreciation estimates are not based on current tax laws, but should represent the asset's annual loss in value.

[2] EPA Estimate = 14 MPG

To properly use this worksheet, the manager must first understand the ownership and operating cost concepts. Ownership (fixed) costs are those costs associated with owning an asset regardless of how much it is used. Ownership costs usually include depreciation, interest, property taxes, insurance, and licenses. It should be noted that the depreciation estimate used in this worksheet is not based on the current tax laws, but should represent the machine's annual loss in value. Interest, property taxes, insurance, and license estimates should be adjusted to reflect the individual situation. Because of the growing investment required in many ornamental businesses, ownership costs must be carefully considered in the decision process because these costs often exceed the operating costs associated with a particular machine. Operating (variable) costs are those costs that vary directly with the use of the machine. That is, these costs increase with greater use and decrease with lesser use. Operating costs relating to machinery consist primarily of fuel, lubricants, and repairs.

In the example, the total ownership cost of the 3/4 ton van was estimated to be $3,642.84 per year and the average cost per mile was $0.18. Although the total ownership cost per year will remain constant, the average ownership cost per mile will decrease if the van is used more than the estimated 20,000 miles or increase if the van is used less. For example, if the van is driven 15,000 miles, the average ownership cost per mile would increase from $0.18 to $0.24, but the total ownership cost per year would still be $3,642.84. Annual operating costs, on the other hand, will decrease with lesser use while the average operating cost per mile will remain approximately the same regardless of the number of miles the van is driven. For example, if the van is driven 15,000 miles the total variable cost per year will decrease from $2,336.00 to $1,752.00 but the average operating cost will still be approximately $0.12 per mile.[1] Therefore, the total annual machine cost will vary from $0.30 per mile ($0.18 + $0.12) if the van is driven 20,000 miles per year to $0.36 per mile ($0.24 + $0.12) if the van is only driven 15,000 miles.

Managers should be aware of these relationships between ownership costs, operating costs, and the annual usage of a machine when estimating the annual machine costs. Overestimation of annual usage will result in the underestimation of the actual machine cost per mile. In the above example, overestimating the use of the van by 5,000 miles will result in the annual cost of the van being underestimated by $0.06 per mile, i.e., $0.18 to $0.24. Subsequently, when the manager estimates the cost of a new job that requires the use of the van, the actual cost of the job will be higher than the estimated cost and the actual profit realized from the job will be lower than the estimated profit.

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[1] Fuel (.07 gal./mile x 15,000 x $1.29/gal.) = $1354.50
Oil, etc. ($0.0065/mile x 15,000) = 97.50
Repairs, etc. ($0.02/mile x 15,000) = 300.00
Total Variable Costs = $1752.00
Variable Cost per Mile = $ 0.12

The next component of the job cost estimate is labor costs. This cost component is especially important for ornamental business since labor typically accounts for a large percentage of the total business expenses. Knowledge of the total cost of labor, not just wage rates, is necessary for accurate estimation of job costs. The total or "true" cost of labor is typically higher than the employee's cash wages. The true cost of labor is increased by the employer's share of the FICA tax[2], Federal and State Unemployment Insurance, Workman's Compensation Insurance, and the fringe benefits provided by the employer. The following worksheets are provided as examples of forms that can be used by the manager to calculate the total cost of labor. The values used in the example are estimates and should be adjusted to reflect the individual situation.

Note that some cost items in the example are costs to the employer, but are not income to the employee. Unemployment and workman's compensation insurance, for example, are costs to the employer, but do not increase the employee's income. Fringe benefits, such as uniform allowance and medical insurance represent income to the employee whether he chooses to use them or not. Other benefits that may be provided by the employer are paid holidays, vacation, and sick leave. These items also serve to increase the employer's total labor cost per hour by reducing the amount of time that the employee is available for work. In this example the total annual cost of the employee was estimated to be $10,772.32. After adjusting for the time that the employee is paid for but will not be available for work, the actual cost to the employer is $5.68 per hour. Thus, the true cost of this employee is 42 percent higher than his wage rate of $4.00 per hour.

Another cost that the manager should be concerned with, is the effective cost of labor, that is, the percentage of time that the employee is "nonproductively" or "productively" employed. Nonproductive employment does not imply the mismanagement of labor or lazy employees. Rather, it refers to the time that is required to get ready to do the job, clean up after the job, move from one job site to another, etc. If 20 percent of the employee's time is "nonproductive," then 80 percent of his time is spent actually "doing the assigned job". To estimate the effective labor cost, the total cost per hour (calculated on the labor cost worksheet) is divided by the percent of "productive" employment, or

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[2]The 1982 maximum FICA taxable wage base will increase from the current $29,700 to $32,400. The Social Security Administration had previously indicated a $31,800 wage base for 1982. The social security tax rate will increase from 6.65% to 6.7% for both the employee and the employer. During 1982, individuals under 65 drawing social security benefits will be permitted to earn $4,440 ($4,080 in 1981) without a reduction in their social security benefits. Individuals 65 to 72 may earn up to $6,000 ($5,500 in 1981).

LABOR COST WORKSHEET

(Example II)

NAME _____

TITLE _____

DATE _____

Cost Item: Cost to Employer

Required Payroll Expenses:

1. Wages (hrs./wk. ____ x no. wks. _____ = total hrs. ____ x wage rate $_____) = $_____
2. Employer's share of FICA tax (6.7% of first $32,400) = $_____
3. Unemployment insurance (0.7% Federal + 2.7% State = 3.4% of first $6000) = $_____
4. Workman's compensation insurance = $_____
5. Total required payroll expenses (add lines 1 through 4) = $_____

Fringe Benefits:

6. Cash bonuses (Christmas or other) = $_____
7. Insurance: Liability = $_____
   : Property damage = $_____
   : Life = $_____
   : Medical = $_____
8. Retirement (Employer's contribution) = $_____
9. Uniform (rental, cleaning) = $_____
10. Meal allowance ____/day x ____ days = $_____
11. Travel allowance (miles/day ____ x ____ days x ____ rate) = $_____
12. Educational expense = $_____
13. Other _____ = $_____
14. Other _____ = $_____
15. Total value of fringe benefits (add lines 6 through 14) = $_____
16. Total payroll expenses (line 5) and fringe benefits (line 15) = $_____
17. Paid holidays (____ hrs.), vacation (____hrs.), sick leave (____hrs.)
18. Total paid hours not worked (sum of line 17) _____ hrs.
19. Total hours on job (line 1 less line 18) _____hrs.
20. Total cost per hour on the job (line 16 ÷ line 19) = $_____

Sources: Beals, A. M. and C. D. Safley, A Simplified Records System for Ornamental Producers, North Carolina State University. (To be published)

NEW JOB COST ESTIMATE FORM

_____
(operation)

NOTE: Complete "ESTIMATE OF ANNUAL MACHINE COST" form for each machine used in this job.

	MACHINERY	COST/HR.	X	HOURS USED ON JOB	=	MACHINE COST
1.		$	X		=	
2.			X		=	
3.			X		=	
4.			X		=	
5.			X		=	
6.			X		=	
7.			X		=	
8.	TOTAL MACHINERY COST (add lines 1 thru 7)					$

	LABOR	COST/HR.	X	HOURS ON JOB	X 1.. =	LABOR COST
9.		$			X 1. =	$
10.					X 1. =	
11.					X 1. =	
12.					X 1. =	
13.					X 1. =	
14.	TOTAL LABOR COST (add lines 9 thru 13)					$

	MATERIALS	QUANTITY	X	PRICE/UNIT	=	MATERIALS COST
15.			X $		= $	
16.			X		=	
17.			X		=	
18.			X		=	
19.			X		=	
20.			X		=	
21.	TOTAL MATERIALS COST (add lines 15 thru 20)					$

	OVERHEAD	OVERHEAD COST
22.		$
23.		
24.	TOTAL OVERHEAD COST (add lines 22 and 23)	$
25.	TOTAL JOB COST ESTIMATE (add lines 8 + 14 + 21 + 24)	$

Source; Reynolds, R.K, and W.R. Luchman, Managing the Nursery Business - Business Management Tools, VPI & SU, MB 275, RV, Part I, 1980.

$$\text{Effective Labor Cost} = \frac{\text{Total labor cost per hour}}{\text{Percent of "productive" employment}}.$$

Therefore, if a worker costs $5.68 per hour and 80 percent of his time is spent in productive employment, then the effective labor cost of this employee is $7.10 per hour, or

$$\text{Effective Labor Cost} = \frac{\$5.68}{.80} = \$7.10/\text{hr.}$$

Some texts use the term "gear up" factor when discussing the additional labor cost that is required for getting ready to do a job or housekeeping after the job. Although this concept is the same as the percent of productive employment, the method of calculating the effective labor cost using a "gear up" factor is slightly different. The "gear up" factor is first determined by using the following formula

$$\text{"Gear Up" Factor} = \frac{1}{\text{Percent of productive employment}}$$

The effective labor cost is then estimated by multiplying the "gear up" factor times the total labor cost per hour. That is,

$$\text{Effective Labor Cost} = \text{Total labor cost per hour} \times \text{"Gear Up" Factor}$$

Using the same values from the above example, the gear up factor is

$$\text{Gear Up Factor} = \frac{1}{.80} = 1.25,$$

and the effective labor cost will be

$$\text{Effective Labor Cost} = \$5.68 \times 1.25 = \$7.10/\text{hr.}$$

The following table is provided to show the relationships between the "gear up" factor and the precent of "productive" employment.

RELATIONSHIPS BETWEEN "GEAR-UP" FACTORS AND PERCENTS OF "NONPRODUCTIVE" AND "PRODUCTIVE" EMPLOYMENT

"Gear-Up" Factor	Approximate Percent of "Nonproductive" Employment	Approximate Percent of "Productive" Employment
1.1	9%	91%
1.2	17%	83%
1.3	23%	77%
1.4	29%	71%
1.5	33%	67%
1.6	38%	62%
1.7	41%	59%
1.8	44%	56%
1.9	47%	53%
2.0	50%	50%

A business that provides materials for a job will obviously include a materials cost component in the job estimate. This component could include such items as fertilizer, chemicals, growth media, replacement plants, etc. In some cases, the cost of additional insurance policies will also be included if they are required to secure a specific job or contract. Costs that may be incurred in getting materials to the job, that are not covered elsewhere, should also be included in this component.

The final component of the job cost estimate is overhead costs. This category includes all the costs, such as utilities, the manager's salary, office expenses, building maintenance and repairs, etc., that are not charged to a job as direct machinery, labor, or material costs. If these items are omitted from the job estimate, the business will not recover the total cost. Several procedures are available for allocating overhead costs, but each requires either extensive records or some estimation.

1. Gross Income: The overhead costs can be allocated among the various jobs based on the percentage of job gross income to total gross income. For example, if the gross income from a job is 15 percent of the total business income, then 15 percent of the overhead costs would be allocated to the job.

2. Per Job: Total overhead costs can be divided equally among all of the jobs, however, this procedure underestimates the costs for those jobs requiring above average use of the overhead items and vice versa.

3. Total expenses: Another procedure that can be used is to calculate the percentage of job expenses to the total business expenses and apply that percentage to the total job costs for a specific job. For example, if the expenses for a job are 20 percent of the total business expenses, then 20 percent of the overhead costs are allocated to the job.

Other procedures for allocating overhead expenses are available to the manager. Although these methods are selected on a subjective basis, the easiest method is to review each expense category and then decide which method is most appropriate to use with that expense.

The following new job cost estimate form will serve as a systematic guide when estimating the various costs associated with a new job. In this example, it was assumed that the Hillsborough plant maintenance job would require one employee four hours per week for 52 weeks to complete.

A "gear up" factor of 1.4 was used to account for the time traveling to and from the job and "getting ready" but not "spent on the job". The total cost (machinery, labor, and overhead) of this job was estimated to be $2,677.71. This value is the break even price, that is, if the manager accepts the contract for this price, he will not make a profit but he will not lose any money either. To calculate a target bid price, which incorporates the manager's profit goal, one of the following procedures can be used.

1. Cost Markup:

Desired markup	20%	
Job cost estimate	$2677.71	
X (1 + profit margin)	x 1.20	
= Target bid price	$3213.25	
Profit (3213.25 - 2677.71)		= $535.54

2. Profit Margin: (assuming the same profit goal)

Desired profit margin	20%	
Job cost estimate	$2677.71	
÷ (1 - profit margin)	÷(1-0.20)	
= Target bid price	$3347.14	
Profit (3347.14 - 2677.71)		= $669.43

Although the manager may decide to bid lower than one of these target prices, he will know how much he can give up before reaching the breakeven price.

REFERENCES

Beals, A.M. and C.D. Safley, A Simplified Records System for Ornamental Producers, North Carolina State (to be published).

Oshurn, D.D. and K.C. Schneeberger, Modern Agriculture Management, Reston Publishing Company, Inc., Reston, Virginia, 1978.

Reynolds, R.K. and W.R. Luhman, Managing the Nursery Business - Business Management Tools, Virginia Polytechnic Institute and State University, MB 275, Rv., Part I, 1980.

Riggs, J.L., Economic Decision Models, McGraw-Hill Book Company, New York, 1968.

IRRIGATION SYSTEMS FOR GENERAL TURF

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A well designed and installed irrigation system is a sound investment for the maintenance and protection of quality turf. The value and use of the turf will determine to some extent the amount of money that can be invested in the irrigation system. There are a number of types of irrigation systems available, but what is feasible for a particular situation will normally be limited. There are a number of factors that need to be considered in designing an irrigation system. These include:

- Water supply
- Soil type
- Type of turf
- Topography
- Size and shape of the area
- Labor available
- Time available to irrigate
- Financial resources

Water Supply

To apply one inch of water to one acre of land requires 27,154 gallons of water but because of evaporation, transpiration losses, and the fact that all sprinklers do not apply water uniformly, it is necessary to apply some 35,000 to 37,000 gallons of water per acre to have an effective inch of water in the soil. Water supplies in North Carolina include impounded ponds, dug ponds, wells, streams and city or county water systems. There are three considerations for water supplies: quantity, quality and location.

Impounded ponds can be constructed any place that soil type is suitable and the topography allows. This limits the construction of impounded ponds in eastern North Carolina. In 1977 the Dam Safety Law was passed. This law states that a pond that has a water depth of 15 feet or more and/or stores more than 10 acre-feet of water requires that a permit be obtained from the Environmental Management Commission, Department of Natural Resources and Community Development. Also a professional engineer must design the dam and supervise construction. The Soil Conservation Service can design and supervise construction on dams where the water depth is 30 feet or less, but their services are limited in some areas due to manpower constraints and the owner must be a cooperator

with the local Soil and Water Conservation District. Most impounded ponds are built on small streams that do not have large flows during flood stage.

Dug ponds are confined to areas that have a shallow ground water level. Most dug ponds are found in eastern North Carolina. Some dug ponds have a recharge capacity, depending upon the type of soil in which the pond is constructed.

North Carolina is not blessed with an abundant supply of ground water. In most of eastern North Carolina, satisfactory irrigation wells can be obtained in most sections, but the quantity of water will vary depending upon location, depth, size of well and type of well construction. In some areas capacities up to 1500 gpm are possible at depths of 400 to 1000 feet. In the Piedmont and Mountain areas, ground water is much more limited. There are areas that have good ground water, but they are isolated. The state has eight regional ground water hydrologists that have good knowledge of ground water available and their services are available at no charge. Their location and telephone numbers are listed below:

Raleigh	919/733-2314
Asheville	704/253-3341
Winston-Salem	919/761-2351
Washington	919/946-6481
Wilmington	919/762-3394
Fayetteville	919/486-1541
Mooresville	704/664-4627
Ahoskie	919/332-2864

Before drilling an irrigation well, a construction permit must be obtained from the Division of Environmental Management, Department of Natural Resources and Community Development.

In many areas streams can be satisfactory sources of irrigation water. The doctrine of riparian rights governs the use of irrigation water. The doctrine states that the owner of property through which or by which a stream passes can make reasonable use of the water, but he cannot appreciably diminish the flow of the stream. Many irrigators are turning to streams for their water source because of the high cost of other water sources.

One piece of legislation that may affect some users of streams and wet areas is the Dredge and Fill Act which is administered by the United States Army Corps of engineers. This is referred to as the 404 permit system and affects dredging and filling in wet areas (wet lands) and streams that have a flow greater than 5 cubic feet per second (cfs). The major concern is placing fill in an area and causing environmental damage to the waterway or wet land.

Most of the water in North Carolina is of fairly good quality. Some of the ground water may have excessive amounts of iron, calcium, magnesium, and in coastal areas, sulfides and sodium. Some of the

sounds along the coast can be used for irrigation, but the sodium level may be excessive during some times of the year. Some surface waters may contain organic waste, heavy metals, pesticides and nutrients, but this is not generally a significant consideration.

Water sources located near the point of use will reduce the cost of pumping and with ever increasing fuel costs, this is becoming increasingly more important. Pumping water long distances increase pipe costs and fuel costs. The pipe cost is a one-time consideration, but the fuel charges occur each time the system is used.

Some turf systems will probably use municipal or community water systems. These are satisfactory, but normally the water is metered and volume and pressure may be limited. If metered water is to be used, the location and size of the meter and the length, size and type of service line from the main to the meter should be determined. Static water pressure and available working pressure will need to be obtained. Table 1 is a guide for determining the maximum amount of water that can be obtained through various size meters. On most city water systems a sewer charge is included in the water rate. It may be advantageous to install the irrigation system on a separate meter, sized for the system demand and not have to pay the sewer surcharge. However, water rates are based on meter size, so do not request that too large a meter be installed. Many times, the static water pressure is not adequate to operate some of the larger sprinklers and it may be necessary to install a booster pump.

Table 1. Maximum Capacity of Various Size Water Meters

Meter Size (Inch)	Capacity (GPM)
5/8	20
3/4	30
1	50
1½	100
2	160
3	300
4	500
6	1000

Soil Type

In examining soil type, items that need to be considered include infiltration rate, i.e., the rate water moves into the soil; water holding capacity, i.e., the amount of water available per unit of soil

from which the plant can extract moisture; physical limitations such as hard pans, high water table, construction materials left in the soil, mixed soils, especially where the turf area has been disturbed during construction and chemical limitations such as low fertility, low pH (acid soil) and high aluminum content. It is important that the system apply water at a rate that will not exceed the infiltration rate of the soil and that adequate amounts of water be applied to meet the moisture demands of the grass.

Crop

In irrigating turf it is important to know when to irrigate and how much water to apply. This will be determined by soil type, rooting depth, type of grass and use of the turf. Generally it is not recommended that cool season grasses be irrigated during their dormant season, but some people are successfully irrigating these grasses. They should not be irrigated frequently and attention should be given to disease control. Warm season grasses require abundant water and fertilizer during the growing season.

The use of the turf will dictate to some extent the amount of water required and when the irrigation should or can be applied. Intensively used areas such as athletic fields (softball, soccer and football fields) will require frequent irrigation and their use may dictate that the irrigation be accomplished early in the morning or at night. Shallow rooting and soil compaction can be a real problem in these intensively used areas and should be considered when the system is being designed.

Topography

The major consideration of topography is the pressure required to pump water to the highest elevation in the area to be irrigated and the requirement for pressure regulating valves that may be needed to provide uniform pressure over the entire area. For each 2.31 feet that water is lifted vertically, one pound per square inch (psi) of pressure is required. Variable pressure in the irrigated area will affect sprinkler performance. To adequately design a system on rolling topography, a topographic map should be available to the designer.

Size and Slope of the Area

Some areas are more difficult to irrigate than others due to shape and size, but it should be possible to design a system to fit odd shaped or widely dispersed areas. This may increase the cost and limit the type of equipment that can be used.

Labor Available

There are a number of types of irrigation systems that can be used for turf. Labor availability will play a major role in the type of system selected, but must be balanced against the cost of the system and less than adequate coverage that may result with labor intensive irrigation systems.

Time Available to Irrigate

Some turf areas, particularly athletic facilities, may be very intensively used and this may limit the time available to operate the irrigation system and also may dictate a particular type of system.

Financial Resources

The financial status of the owner may dictate the type of irrigation system that will be purchased. Some turf areas may not support expensive systems. Extensively used areas may dictate an automated system. The initial cost of the system needs to be balanced against the labor required to operate the system and the cost of the labor over the life of the system. One also has to examine the type of irrigation job that will be done and what cost system the turf area will support.

An irrigation system is only one component of a total production system. A well designed, properly installed, operated and maintained system will accomplish the purpose for which it was intended; that is, apply water to soil in order to provide a more favorable environment for the production of quality turf.

There are a number of systems on the market ranging from the hand-held garden hose to sophisticated automatically controlled systems. The cost of systems vary inversely with the hand-held hose being least costly and requiring the most labor and the automatic system being most expensive and requiring the least amount of labor. The basic types of systems listed in increasing order of cost are:

- Hand-held hose with or without a nozzle
- Soaker hose
- Portable sprinkler on a base or spike with water supplied by a hose
- Water powered or engine driven traveling sprinkler with a flexible hose or hard hose
- Portable aluminum pipe system
- Center-pivot irrigation system
- Trickle or drip irrigation system
- Quick coupling valve system
- Manual valve control rotor pop-up or gear drive pop-up permanent systems
- Manual valve control spray head system
- Automatic control rotor pop-up and spray head system

The hand-held hose is probably one of the most used watering systems and the most useless. To wet most soils to the desired depth, some two to four hours will be required and this is impractical with a hand-held hose. Soaker hose is only adaptable to small areas of turf on fairly permeable soil types.

Portable sprinklers on a base are only useful on small turf areas. It requires labor and patience on the part of the user to do a good job of irrigation. The general tendency is to overirrigate small areas, but

most of the area is underirrigated. The best sprinkler to use is a rotary impact or gear drive with a 5/32 inch orifice which discharges about 4.4 gallons per minute (gpm) at 40 pounds per square inch (psi) of pressure. This sprinkler will have a 75 to 80 foot diameter and using a 40 to 45 foot spacing can do a good job of irrigating if the sprinkler is operated for 4 to 5 hours at each location. This will give a total effective application of about one inch of irrigation. These sprinklers can also be purchased as part-circle models which allow them to be used next to buildings, sidewalls, streets, etc. In the part-circle mode of operation, the application rate is increased since the volume is applied on a smaller area. Some homeowners use wave or oscillating sprinklers. These irrigate a rectangular area, but the rate of discharge is generally unknown and unless a rain gage or coffee can is used to measure the volume applied, it is difficult to know how much water has been applied.

The water-powered or engine drive traveling sprinkler was originally designed to irrigate turf areas such as athletic fields, memorial parks, etc. These were small units that use a 1 to 1½-inch diameter hose and up to a 30 gpm sprinkler. With these units, areas up to 400 feet long by 110 feet wide can be irrigated at one setting. This is a continuous move unit. The amount of water applied is adjustable. The system requires 85 to 100 psi pressure at the pump or water source. Normally water is supplied to the traveler hose through buried pipe and quick coupling valves or hose bibs. In recent years, larger traveler units have been introduced. There are two types of these units, cable-tow and hose-drag. The cable tow units use a flexible rubber hose and follow a steel cable. The hose drag units use a large drum around which a polyethylene hose is wound and water is supplied to a sprinkler cart from the hose. The winding of the hose around the drum moves the sprinkler cart through the field. These units are available in various hose sizes from 2-inch to 5-inch and lengths from 330 to 1320 feet. The larger units can cover areas up to 2500 in length and 330 feet wide at one setting. They have high pressure requirements; in the range of 140 to 200 psi at the pump or water source. These units would be used to irrigate large turf areas.

Portable aluminum pipe systems have limited use on turf. They may be used to aid in stand establishment and can be used on small turf areas, but the labor involved to move these systems with the frequency with which turf needs to be irrigated make them impractical for most turf areas.

Center-pivot irrigation systems are available in sizes from 7 to more than 500 acres. They would have limited use in most turf areas, but might be used for extensive turf areas, especially in wastewater land application systems. The linear-move system is similar to the center-pivot except that it moves in a straight line across the field. It can be used on large turf areas on relatively flat topography. Both the center-pivot and linear systems require that the area be free of obstructions such as power lines and buildings. Ditches can be crossed even if they have to be bridged.

There is limited use of trickle irrigation for turf. A few systems have been sold for home lawns. Normally perforated pipe has been installed beneath the ground surface at depths of 6 to 12 inches on spacings of 18 to 24 inches. Some subsurface irrigation systems have been installed on athletic fields, but these are custom constructed fields that include black plastic, gravel, drainage tile and a pump system to allow water to be pumped into the system for irrigation and pumped out for drainage. This is a very expensive system and installation is critical to insure that the system will function as designed.

The quick coupling valve system is a permanent installation. The valves are connected to buried pipe, normally polyvinyl chloride (PVC) plastic. At each location where a sprinkler is required, a quick coupling valve is installed with the valve cover flush with the ground surface. Valve covers are metal or rubber covered, with or without locking devices. Valve opening keys are fitted with a handle and threaded on top to receive a sprinkler or swivel hose ell. To use the system, a key with sprinkler attached to the top is inserted into the valve and turned to open the valve. Depending upon the volume and pressure of available water, one or more sprinklers can be operated on the system at one time. When the proper amount of water has been applied, the valve is closed and the sprinkler is moved to another valve location. Normally, full or part-circle rotary or gear-drive sprinklers are used; however, nonrotating sprinklers can be used. Considerable time and patience are required to use this system, but the moving of pipe is eliminated and if the sprinklers are moved on a timely basis and left in place long enough, a satisfactory irrigation job can be accomplished. Swivel hose ells can be used to attach a hose to the valve for spot watering or for filling sprayer tanks, etc. Many golf courses are irrigated with this type system, but the cost of labor and problems associated with improper water management is forcing a change to automated systems.

Manual control valve permanent systems are widely used, and if properly designed and operated will do an excellent irrigation job. The owner or operator must be available to operate the system during periods of moisture stress or the system is useless. The supply pipe is placed underground. The sprinklers are installed on pipe risers with the sprinkler tops flush and level with the ground surface. One or more sprinklers are installed on a supply line with the total demand not to exceed the volume and pressure of water available. This is called a zone and most turf areas will require several zones. Each zone is controlled by a manual angle, globe or gate valve. If possible, the valves should be placed in valve boxes located in a convenient place for the operator and out of the range of the sprinklers. A minimum number of valve boxes should be used. Rotor pop-up, gear drive pop-up and spray head sprinklers can be used with the manual valve system.

The most expensive irrigation system is the completely automatic permanent system. Electric or hydraulic valves are used to control the various zones. The valves are activated by an electric controller which has the control features needed for that particular system. With

the addition of a moisture sensor wired into the controller, the system can be made totally automatic. Without the moisture sensor, the controller has to be set to activate the system. The same type sprinklers are used for the manual valve and automatic system. The cost of the automatic system is approximately 25 percent greater than an equivalent manual valve system.

There are a variety of piping materials that can be used for irrigation, but most permanent systems being installed today use PVC plastic pipe. This material is available in pressure ratings of 125, 160, 200, and 315 psi. This is called Class pipe. Sizes vary from 1/2 inch to 12-inch, but sizes below 1 inch are not recommended. Connections include solvent-weld and ring and gasket. The ring and gasket PVC pipe is available in sizes 1½-inch and larger. In pipe sizes about 4-inch, most contractors prefer the ring and gasket pipe and some will use ring and gasket in sizes as small as 2-inch. Some medium and high density polyethylene (PE) plastic pipe is used for irrigation. Galvanized steel or copper pipe may be used in certain locations requiring strength or to meet plumbing code regulations. The minimum recommended burial depth for PVC and PE pipe is 18 inches and for sizes 6-inch and above it should be buried to a depth of 36 inches.

For portable irrigation systems, aluminum tubing is the primary piping material. Its nominal pressure rating is 150 psi and it is available in diameters from 2-inch to 12-inch.

Most of the drip irrigation systems use low density, high carbon polyethylene pipe for the lateral lines. Supply lines will be PVC or PE plastic pipe.

Sprinklers for irrigation are divided into four types: rotary impact, spray heads, internal gear drive and oscillating. These sprinklers are constructed of brass or plastic with a large number being made of brass. However, plastic is gaining wider acceptance because of the lower cost and the improvement in materials. Most of the sprinklers used on the travelers and for portable systems will be rotary impact. The permanent pop-up rotating sprinklers will be rotary impact or gear drive. These sprinklers are available as either part or full-circle, with radii of 25 to more than 100 feet. Part-circle sprinklers are adjustable for a coverage from 20^{o} to 340^{o}. Cases will be of either plastic or iron construction. The plastic cases are used mainly for residential and light commercial installations. Where heavy turf maintenance equipment will be crossing the sprinklers, the iron cases should be used. The minimum spacing between these sprinklers should be 25 feet and spacing depending upon sprinkler capacity can be as great as 140 feet. For pop-up sprinklers, a 2-inch minimum pop-up height is desirable to prevent the grass from interfering with the sprinkler discharge. In recent years water distribution devices on center pivots have taken on a variety of configurations. Many center pivots now use low pressure spray heads, controlled droplet size rotary impact and other low pressure devices. Often pressure requirements are in the range of 10 to 30 psi. The rotary impact and internal gear drive sprinklers have pressure requirements from 30 to 85 psi.

Stationary or spray head sprinklers are available in pop-up assemblies for lawn use or as shrub head (without the grass flange). Radius of coverage varies from less than two feet for bubble head to over 20 feet for some stream spray heads. Most spray heads have adjusting screws for reducing the radius of coverage. Spacing between heads should not exceed manufacturers' recommendations. Spray head sprinklers are available in fixed patterns as full, quarter, half and three-quarter circle, square and strip and are constructed of brass, plastic and die cast metal. Operating pressures are 15 to 30 psi. Application rates will vary from one to three inches per hour depending on model selected and spacing. Spray head should not be placed on the same zone with rotary impact or internal gear drive sprinklers. In fact, generally full, quarter and half-circle spray heads cannot be placed on the same zone because of the variation in precipitation rate.

Spacing for fixed rotary impact, internal gear drive and spray head sprinklers should be in the range of 50 to 65 percent of diameter to provide as uniform water application as possible. Spacing between traveling sprinkler should be about 75 percent of diameter. Spacing between sprinklers may be square, rectangular or staggered or a combination of the three. Manufacturers' literature gives performance data, specifications and precipitation data on their products.

Oscillating sprinklers are mostly used for lawn irrigation. Most have a rectangular pattern. To obtain uniform watering they also require overlap, but there is no standard recommended overlap.

As mentioned earlier, automatic valves can be either electric or hydraulic. Valves are constructed of either brass or plastic. More plastic valves are being used. There are several types of electric valves. Some are designed to handle water that contains some foreign matter. Others require fairly clean water. Most electric valves are normally closed; this means that they fail in the closed position. Some electric valves require two individual wires from the valve to the controller; others use a single hot wire and share a common ground with other valves. The activating solonoid on most valves is low voltage (24 to 30V). More than one valve can be operated on the same station on the automatic controller.

Hydraulic valves are controlled by a fluid, either water, air, or oil. Most hydraulic valves are available as normally open, but normally closed hydraulic valves are available. Pressure differentials in the system can cause problems in the operation of hydraulic valves. Freezing temperatures can also cause a problem with water activated hydraulic valves. However, this can be overcome by putting antifreeze in the liquid. An electric controller is used with hydraulic valves.

If the system is properly designed, either electric or hydraulic valves are satisfactory. Each system has some weaknesses and strengths. In this part of the country there are probably more electric valves used; in other parts of the United States, more hydraulic valves are used. The main considerations are relative cost and availability of service.

Controllers are available in a variety of designs. They range from simple one station clocks to activate a mist propagation bed to multistation units that may or may not include a moisture sensor element that can control a large area. For extremely large turf areas, satelite controllers may be used out on the course with a master controller located in a central area of the course. Most turf controllers have adjustable operating times from a few minutes to one hour. Most of the multistation controllers have the capability of repeat cycle operation; that is, the time period that a particular station is set to operate can be repeated. Controllers may be wall mounted or pedestal mounted. The greatest threat to controllers is lightning. A part of the system should include lightning arresters and a proper ground. If electric valves are used, the valve activation side of the controller should also be protected.

Depending upon the water source, pumps and power units may be required on the irrigation system. All irrigation pumps are some type of centrifugal pump, either straight centrifugal, line shaft turbine, or submersible. Power sources may be either electric or internal combustion: gasoline, diesel, LP gas or natural gas.

Each of these types of pumps have some limitations and are best suited for particular purposes. Straight centrifugal and self-priming centrifugal pumps have a maximum suction lift of 12 to 22 feet depending upon the particular pump. This means that the elevation difference between the water source and the pump intake should not exceed the value listed above. Priming of centrifugal pumps is accomplished by excavating the air from the suction line and letting atmospheric pressure replace it with water. A leak in the suction line, or at the suction inlet or discharge check valve will prevent the pump from priming. This one problem accounts for about 90 percent of all pump problems. Priming is accomplished with a hand diaphragm primer, exhaust manifold primer, intake manifold primer, or electric manifold primer. To solve the problem of priming, it may be desirable to use a flooded suction where the pump is located below the water level, such as having the pump located on the downstream side of the dam with a pipe through the dam.

With automated irrigation systems, it is especially important that the pump remains primed. This can be done with a flooded suction, foot valve on the suction pipe or use a pressurized system. Most turf irrigation systems where irrigation is needed almost continuously for a long period of time use pressurized systems where a small pump operates continuously and larger pumps are activated as needed.

The line shaft turbine and submersible pumps are located in the water source below the water level so priming is not a problem. Safety controls, such as low water level electrodes and low pressure switches are normally installed to protect the pump and motor if the water level drops below the pump intake. These two pumps should be used with water sources that have a minimum amount of foreign materials.

Pumps are available to meet almost any need. The important consideration is to select a pump and power unit that meets the desired needs and that has as high efficiency as possible. The irrigation dealer has characteristic curves on all the pumps he sells.

There is a wide variety of equipment available to be used in irrigating turf. The system designer should follow a logical sequence of steps in his design procedure. He should determine what the customer desires and what he can afford to invest. Often there must be some compromise in these two issues. The designer should inform the client of the various types of systems, their labor requirements, relative cost and application efficiency. Design costs are passed on to the customer, either as a direct cost or in the cost of equipment. It is too expensive to prepare more than one complete design. If the system is to be expanded in the future, this should be considered at the initial planning stage.

Once agreement has been reached on the system to be considered, the designer should obtain a plot plan and possibly a topographic map and on large sites, a soils map would be helpful. Only natural or man-made obstacles should be shown on the plot plan. The plot plan should be to scale.

Equipped with the necessary data, the designer begins to fit the system to the site. He operates within constraints that may force some compromise in the design. The irrigation system should have capacity to meet the maximum water demands of the area. The application rate should be less than the infiltration rate of the soil. From an engineering standpoint, the maximum pressure variation in the system, including elevation differences should be ± 15 percent of the design sprinkler pressure. On some systems, several different size sprinklers with different capacities and pressure ratings may be required. This may require pressure regulating valves. The system should not operate continuously. Some time should be allowed for maintenance and repairs in case of equipment failure. Most systems will supply water to only a portion of the area at one time. This means that the system will have several zones. The zones should have as near equal flow as possible. Some areas, due to turf species, soil type, topography, or intensity of use may require different amounts of water or frequency of application. This must be considered in the design.

Flexibility should be designed into the system. On most large systems, the main line pipe may be installed in a loop. This means that water may be supplied to a zone from two directions. In case of equipment failure, the whole system is not shut down, but only the portion where the failure occurred. Some areas may need daily irrigation, and this must be considered. If freezing weather is a problem, provisions must be provided to drain the system. Valves, system controls and motor controls should be easily accessible. Back-up pumps may be required. For systems that may have variable water requirements, more than one pump may be required.

Reliable equipment, supplied by local companies, should be specified. Safety controls should be required. These include air relief valves, pressure relief valves, motor or engine protection, slow opening and slow closing valves. Specifications should be written to ensure that the materials supplied and the installation are as the designer specified. An as-installed plot plan should be prepared once the system is installed.

There are at least two schools of thought on who should design irrigation systems. Most systems are designed by irrigation engineers, landscape architects and consulting engineers. My feeling is that a system should be designed by a person who knows irrigation equipment and is well grounded in the fundamentals of irrigation design. What the user desires is a system that is economical in price and yet accomplishes the desired irrigation. While there may be some variation in the fee charges by various designers, the small amount saved in design cost may be spent many times over if the system does not accomplish the purpose desired. Select a designer that has designed successful systems.

The last portion of the design is operation of the system. The designer should provide an operating schedule. Changes in turf may dictate changes in schedules, but the designer should certainly provide an initial schedule. The designer should work with the installer to ensure that the system is properly installed and any changes in equipment or installation should be approved by the designer in consultation with the owner.

Once the system is designed and installed, the owner has the requirement to operate and maintain the system. If any of the three steps (design, installation, or operation and maintenance) are neglected, the system will not do an adequate job.

Since irrigation systems are mechanical devices, there will be failures and some maintenance will be required. Part of the maintenance problem can be handled through selection of quality equipment and proper installation of that equipment. On permanent systems, sprinklers should be installed on swing joints. These joints absorb some of the shock of the equipment running over the sprinkler and allow the sprinkler height to be adjusted. Gravel should be placed around all pop-up sprinklers. This will prevent a wet area around the sprinklers and should prevent soil and other foreign material from getting into the working mechanism. Sprinklers and valves should be selected so that the working portions can be removed from the top of the sprinkler or valve. Valve boxes should be used to enclose all valves whether manual or automatic. Care should be taken in installation of pipe to ensure that joints do not leak. Wire connections should be made water tight. Air relief and pressure relief valves should be installed in pipe. Valves should be slow opening and slow closing to lessen the problems with water hammer. Provisions should be made to drain the system during freezing weather.

The contractor should furnish a list of operating instructions and these instructions should be followed. Equipment operators should be trained to be alert for malfunction of the equipment. Operators of mowers, sprayers, etc., should be shown where sprinklers, valves, etc., are located and cautioned about running over the equipment. The irrigation system operator should check the system occasionally. Run the system through a cycle and see if the sprinkler patterns are adequate. Check the pressure on the system. This can be done with pilot tubes and pressure gages or gages located at various points in the system. Watch for tell-tale signs of leaks such as a wet spot.

Maintenance should be preventative rather than corrective. A small amount of time and money spent in preventative maintenance will negate the need for expensive corrective maintenance. The key is the selection of good equipment and a properly designed, installed and operated system.

CONSTRUCTION DAMAGE TO SHADE TREES

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Traditionally the primary importance of shade trees has been the aesthetic quality and beauty. These qualities are difficult to quantify Trees and other landscape plants have assets far beyond their aesthetic value. Plants, by their photosythetic processes, are essential to all mankind. Presently, as an "energy conscious society", we value shade trees for the climatological uses; cooling effect, wind direction and control and solar radiation. Landscape architects use trees as a tool to create spaces, screening, and privacy and as architectural compliments. Noise abatement, air purification and traffic control are among the engineering uses of plants. Planting designs utilize trees from an aesthetic and functional viewpoint. Often the people who appreciate trees the most are unknowingly causing them the most problems.

Damage to trees during the construction process is a rather common phenomenon. Trees will often decline as a direct result from construction such as physical damage to trunk and sometimes the decline and/or death of the tree will be from a secondary factor, such as a weakened tree being more susceptible to insect infestations.

The first step in knowing how to protect trees is knowing "how a tree grows". Remember, trees are living objects and grow natively in an undisturbed environment. When construction interfers with this environment, problems often occur. Contrary to popular belief the majority of the lateral roots of an undisturbed tree are in the top 12 - 18 " of the soil profile and extend beyond the spread of the tree. the feeder roots occupy the top 4 - 6 inches of soil where they form a most effective and essential network which not only absorbs water and nutrients but also carries out oxygen - carbon dioxide exchange. Very often the feeder roots of trees growing in a lawn occupy the same root zone.

Keeping in mind "how a tree grows", let's examine the various forms of construction damage. "Cut and fill" is a familiar term among contractors and engineers ... and also among arborist. Roots can be damaged during the excavation of footings and foundations. When the normal oxygen and water supply is interrupted by piling soil over the roots - damage can occur. Vehicles, delivering materials often compact the soil to an extent that the roots are crushed. Tire ruts can accumulate rainfall which can drown more roots. Ditching can damage the root systems. Paints, varnishes and solvents spilled on the soil can injure roots. One of the most familiar causes of damage is the surfacing or paving around nearby trees. Disregarding the initial construction, the lack of water and oxygen under the pavement will injure the roots.

Now that you are aware of the many hazards to which trees are exposed during construction, let's examine "how to protect trees" during the construction process. In order to properly protect trees from construction activity you must not disturb the selected trees. On a wooded site all trees cannot be protected, therefore, one must first determine which trees are worth saving and how many trees can be properly protected. This requires a site analysis and proper inventory of existing vegetation. With saving trees as a top priority a landscape architect can work with architects and builders in locating and adjusting the building to the site. Be certain that the trees which are marked for protection are worthy of protecting. Choose healthy trees with developed crowns and trunks free of basal decay and injuries.

Protection of trees requires more than a colored ribbon. Padding the trunk with lumber may protect it from minor collisions, however, offer little protection to the trunk from hugh bulldozers and no protection to the roots. Barriers and fencing provide more protection, if properly installed before construction. Minimum protection is afforded if the barrier encircles the tree at a distance no closer than one foot for every inch trunk diameter. For best protection each barrier should encircle the entire area under the tree (drip zone) or one large barrier around a group of trees. Barriers should be of substantial material: 4 x 4 posts - 2 x 6 rails. Barriers discourage compaction of soil, trunk damage and cut and fill beneath the tree.

As trees grow, mature and die obvious problems are created for maintenance personnel. The majority of these problems should be eliminated on the drawing board. A more extensive use of trees in the "small ornamental trees" category should be specified by landscape architects in competitive landscape areas. For Southeastern areas the following trees are often used: crape myrtle - Lagerstroemia indica; dogwood - Cornus florida; Japanese maple - Acer palmatum; redbud - Cercis canadensis; American holly - Ilex opaca.

The implementation of "tree-form" evergreen shrubs should be considered. Burford holly - Ilex cornuta "burfordi"; Carolina cherry-laurel - Prunus caroliniana; Wax-myrtle - Myrica cerifera; Foster holly - Ilex opaca x cassine "Foster"; photinia - Photinia glabra and liqustrum Ligustrum lucidum are all evergreen shrubs capable of being grown as small evergreen trees.

The concepts, theories and underlying ideas of the site analysis, proper selection and use of trees, and adequate protection of existing vegetation, should be incorporated as operational procedures in the development process. Communication and co-operation among landscape architects, arborists and developers is a necessity, in order to facilitate the creation of compatable landscape features.

Horticulture in High Point

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Horticulturist
City of High Point

The landscape Section is a part of the Parks and Recreation Department of the City of High Point. It has been a specific operation, as it is today, for 9 years. I am the first Horticulturist hired by the Department to organize and operate this section.

Its purpose of origin was, and is, to evaluate, design, construct and maintain those grounds allocated to Parks and Recreation Department and assigned to the Landscape Section. This consists of the following areas:

(1) 128 traffic islands and cul-de-sacs that are curbed and guttered.
(2) 42 acres of miscellaneous street-related maintenance areas such as parkways.
(3) Special areas such as Downtown Core, Mini-Mall, two parking plazas, employee parking lot, museum grounds, planter tubs, and tennis center.

In addition to the above permanent assignments, this section consists of other sections of the Parks and Recreation Department with landscaping and beautification projects. Some examples would be tree plantings at parks, playgrounds, golf courses and marina areas; landscaping of special areas such as recreational service centers, headquarters building, marinas and club houses; and the use of labor and equipment to assist other sectional projects as needed.

The facilities of this section are also used to assist other departments of the city with their landscape projects. Examples are plantings at other city facilities such as water plants, electrical sub-stations, city garage and gas facility, sewer filtration plants, landfill areas, city hall and fire stations. The policy is for this section to utilize its resources in developing these special areas and to provide supervision and some maintenance through the first year after planting. In addition, we are used as consultants on disease and insect problems and in many cases do the eradication or control procedures with our labor and equipment.

This section is allocated eight permanent and two seasonal employees. Our basic equipment consists of: (1) Ford 400 tractor with attachments such as front end loader, mole board plow, disc harrow and spring cultivator; (1) Kubota with Wood's mower and rototiller; (1) 2-1/2 ton dump truck flat bed and miller trailer; (4) pick-ups; (1) Toro grounds master and trailer; (4) hand tillers with exchangeable tines; (8) hand mowers; (2) weed eaters; (1) 42" Vermeer tree spade; (1) mist blower, wet or dry; and assorted hand tools of the trade. A budget of $234,000 is allocated to this section. This covers all equipment, salaries, supplies, and operating expenses of the section. It does not include Capital Outlay projects materials.

Traffic islands and cul-de-sacs are classified into three types of maintenance programs. These are "low" consisting basically of grass only.

They are mowed every 10-14 days during the season, edged once with aeration and de-thatching as needed and a minimum of fertilization. Those areas consisting of grass plus a small planting (usually trees and/or shrub group) are classified as "medium". Grass is handled about the same as low, but with additional fertilization; mulching the plantings is renewed each year. All trees and shrubs are fertilized once a year using slow release formulations. Mulch areas are kept free of weeds and grasses by the use of chemical control or hand pulled. "High" designates those areas having additional landscaping improvements such as bulb and flower beds, and in some cases structural additions. Most of these high areas are in locations having a high density of travel or on main thoroughfares of the city. These areas receive the works and are considered the focal and vocal points of our work. In these areas, all the work is calendarized and programmed to assist those responsible in preparing their work schedules and sharing the equipment needed.

Our total work area is divided into three working groups with a person assigned as responsible for a particular group. This assignment is permanent with rotation of assignments every 18 to 24 months. The balance of the work force is assigned daily to the different work areas on the basis of what is to be done. Each group leader keeps a daily log to report and record the group's activities, visitations, tools used, and time allocated. On the back of the log sheet is noted remarks about anything noticed during the day that needs further attention. These remarks are used to help build another day's activities or to note problems needing special attention such as disease and insect infestations. We have one person in the section with the responsibility of knowing and doing most of the chemical control for diseases and insect problems, special pruning, and installation of new areas. This person also keeps up and carries out preventative maintenance programs on recommended disease and insect controls.

We have found this procedure of assignment to far excel the routine "crew" assignment in efficiency for our section. It provides more varied training of employees, it breaks up the gang and monotony of routine plus providing a much broader base to evaluate all employees twice a year which is a city personnel requirement used to set pay scales. We feel it also lessens the chance of "free riders" on the work force. Our section feels with pride that our efficiency in work production stands among the tops in overall city work force of nearly a thousand emplovees.

Each year our section targets 8 to 12 projects for new development or renovation of older ones. These are determined within the department or other city departments, added aesthetic value to neighborhood, or to improve the maintenance procedure of an area. This has resulted in our growth from a work force of three in 1973 to our present allocation of personnel and equipment. It has helped us in developing two field nurseries, a container nursery, three greenhouses, assorted cold frames, shade house, and a separate base of operations.

Like all sections, we do have some problems. Probably the most prevalent and difficult one is that in most areas where we are asked to assist, or old ones we attempt to renovate, we run into terrible ground conditions. Almost all traffic islands and cul-de-sacs are dump grounds

for construction residue. Anything to fill the void between curbing is permissible. Another is the trash problem, and it increases as the areas are developed for it provides stopping places for litter. As cars become more compact, sight clearances on the old city ordinance are out dated and require further work on our part. In some instances, a complete new landscape. Pure vandalism is becoming more prevalent. And like many other sections, to stretch the allocated monies so as to maintain and improve our section becomes more of a challenge.

Some new innovations we are working with as possible helps are: the increased use of chemical controls using pre- and postemergence applications; the possibility of using growth regulators; increasing size of initial plantings such as trees and foundation shrubs from our nurseries, production of all annuals and perennials by our staff, extending planting season by the use of a large type container growing system. This will allow replacements and new installations at anytime of the year with plants adapted to the soil and climate conditions of its new and hopefully permanent home in the landscape.

We, of the Landscape Section, take pride in our program and feel that we have added our bit to a city beautification program for the City of High Point that has been well received. Congratulatory calls, notes and remarks far outnumber the dissenting ones which makes for a harmonious environment in which to work. This is good for the employees, our supervisors, and for yours truly. We invite you to come and see!

Maintenance of Turf in Municipal Areas

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There are several divisions within two departments of the City of High Point that are responsible for maintaining turf owned by the taxpayers of High Point.

The Street Maintenance Division of the Public Works Department maintains 171 miles of right-of-way and 62 lots within the city. Maintenance consists of mowing, growth regulator spraying, and edging of curbs within the Core areas of High Point. This is accomplished by two crews using four tractor-bush hogs, two slope mowers, and various small mowing equipment.

The Grounds and Landscape Section of the Parks Division of the Parks and Recreation Department are responsible for maintaining turf within the non-revenue producing parks of the system. The Grounds Section of the division cares for the fifteen athletic fields within the 115 acres of parks it maintains. Upkeep of sixty acres of curb and gutter islands, median strips, cul-de-sacs, etc. are delegated to the Landscape Section, since these areas contain a large amount of plantings. Equipment used by these sections consist of three out-front mowers, three tractor-bush hogs or flails, a seven gang reel mower, and different types of smaller mowing equipment.

The Special Facilities Division of the Parks and Recreation Department is charged with the upkeep of turf within the revenue producing facilities of the parks system. Since these areas consist of two golf courses, two large parks, a campground, and two swimming pools, they are wide spread across the city and must have a crew of two-four employees based at each facility to maintain it. This division is responsible for 2500 acres of property, of which 300 acres is maintained turf areas. Basic pieces of turf equipment are utilized at each facility, with the more exotic types being held in a pool for use by each area when needed.

The A.J. Simeon Stadium was built by the City of High Point and leased to the High Point Public School Board. It is maintained by the School Board and a private contractor. The playing field sees 40 to 45 games per year, which come from six junior and senior high schools.

Maintenance standards are set for turf areas within the city. Golf greens receive daily attention such as mowing, cup changing, ball mark lifting, watering and spraying during the summer. Athletic fields, fairways, and tee areas receive bi-weekly mowings, irrigation when needed, and nutrients according to soil tests. Lawns around buildings and rough areas are mowed

weekly and receive fertilization and liming every other year. Traffic islands, cul-de-sacs, and other park areas receive mowings every ten to fourteen days. Outlying grass parking areas, dam areas, and vacant fields are mowed every thirty days while vacant lots and right-of-ways are trimmed twice a year. Deep rough areas on the golf courses and fields around the watershed area, are cut once a year.

Several types of turf have been tested under certain conditions. Zoysia was installed at the waterslide area since it holds up well under traffic and is slow growing. Mid-iron hybrid bermuda sod was purchased to cover a playfield in a urban renewal section where housing demolition had taken place. Va-mont hybrid bermuda has been purchased to sprig athletic fields. Common bermuda is planted on some athletic fields and most grass parking areas. All golf greens are Penncross bentgrass and nineteen having been converted from common bermuda to hybrid to bent. Lawn areas are basically K-31 Tall Fescue. One golf course has approximately 80% Merion, Baron and Fylking bluegrass in the fairways which is considering converting to bermuda to cut down on irrigation expenses.

The herbicide program consists of pre & post emerge applications and soil sterilization. Soil sterilants are used in electric sub-stations and around non-living structures where lateral movement is not a problem. Pre-emerge herbicides are used on greens, tees, fairways, athletic fields and selected lawn areas. Post emergent herbicides are applied on fairways, greens and around living ornamentals as per directions. Some problems have been encountered with wind drift, herbicide residual and lack of total control of the pest.

Too much water has caused problems, especially at one golf course which is located in the drainage area for the southside of High Point. Since this has happened as many as six times a year, the course has been re-designed to handle most of the water. One green was completely rebuilt, only to have it wash out, when the seed had started germinating.

Other problems encountered have been with people and vehicular traffic causing a tremendous amount of compaction. At the annual drag boat races, 10,000 people, 500 vehicles and boats trample a twenty acre area. The turf in this area is normally cut at a six inch level. However during this past race, the turf was mowed to one inch to designate the pit areas because of rain nightly before the race. Another area of extreme compaction has been created in a playfield used by large company picnics. After these events, these areas are normally aeriated, fertilized and re-seeded depending on the time of the year and the type of turf.

Turf serves many facets in the municipal setting. It is used for roadside stabilization, erosion control, recreation and has an aesthetic value to many people. It can serve as a backdrop for a boatrace, a concert audience, a beer bottle, or a place to walk the dog. Aesthetics are one of the few things people have for free.

NEMATODE PROBLEMS ON TURFGRASSES

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Nematodes are small eel-like worms that are too small to be seen with the unaided eye. Many species that live in soil and water feed on other microorganisms and are considered to be useful members of the ecosystem. Some species are harmful and cause diseases in plants and animals. Nematodes that are parasitic on plants have stylets which are small spear-like structures that are used to puncture plant cells to obtain nutrients. Some species cause root stunting, some cause abnormal growths on roots, stems, leaves or seeds, and some species cause no apparent damage even at high numbers.

Plant parasitic nematodes reproduce by eggs that hatch into small nematodes called larvae. The larvae develop through several molts before becoming adults. The life cycle may be completed in three to four weeks under optimum conditions with each adult female nematode producing several hundred eggs in a short time. The larvae hatch from the eggs, and they must feed on a suitable host plant or they will die. Most nematodes do not kill the host plants, but weaken the plants and make them more susceptible to other stresses. Nematodes that feed on the roots of turfgrasses can be separated into two groups known as endoparasites and ectoparasites. The endoparasites pentrate the plant and move around in the plant tissue, whereas the ectoparasites use their stylets to puncture plant cells and do not enter the plant with their bodies. The ectoparasitic types cause most of the damage to turfgrasses.

Symptoms of nematode damage above ground usually appear as plant stunting, nutient deficencies or excessive and rapid wilting during dry weather. These symptoms are typical of a damaged root system that could be caused by other factors. Symptoms of nematode damage on root systems may be stunting, excessive branching of roots, lesions or even death of a large

portion of the root system. The damage to the root system reduces the ability of the plant to take up adequate amounts of nutrients and water for maximum growth, therefore, the symptoms described above may develop. These symptoms usually are not adequate to identify nematode problems on turfgrasses, and soil samples must be assayed for nematodes to determine if damaging levels of certain nematodes are present. Information on how to collect soil samples, information sheets and properly marked soil boxes for nematode assays are available from your local county agent's office. The samples are sent to the Nematode Assay Laboratory that is operated by the Department of Agriculture in Raleigh. There is a charge of one dollar per sample for nematode assays.

Nematodes that are found most frequently on turfgrasses in North Carolina are ring, stunt, spiral, lance, root-knot, stubby-root and sting. Only the sting and stubby-root nematodes have been shown to cause severe damage on turfgrasses in North Carolina. The other nematodes may be present in high numbers, but results in greenhouse and field experiments have not shown severe damage from these nematodes. The sting nematode has been associated with severe damage on both cool season and warm season grasses on golf courses and in home lawns in sandy soil areas of eastern and south central North Carolina. It is difficult to grow good quality turfgrasses where this nematode is present. The stubby-root nematode occurs in most areas of the state and has been shown to cause severe damage on some cool season grasses on golf greens. The lance and ring nematodes often are found in high numbers on poor turf, but research results have not shown that these nematodes cause severe damage to turf in North Carolina.

Chemicals for nematode control, nematicides, are available for use only on golf courses or commerical sod. These chemicals are very toxic and are not labelled for use in home lawns or residential areas. The soil should be assayed to determine if sufficent numbers of damaging nematodes are present before treating golf courses or sod with nematicides. If nematicides are used, follow the label directions carefully. In cases where nematodes are a problem and nematicides cannot be used, some management practices

can be used to help overcome the effect of the nematodes. Maintaining proper soil pH, nutrition and mosisture for good turf growth will help some grasses overcome the damage from some nematodes. In some cases an alternative to the species of grass that is being grown may be considered. For example, centipedegrass may the damaged severly by sting nematodes, whereas bermudagrass or bahiagrass may be able to survive and produce an acceptable turf in the infested area with proper maintenance.

In summary, certain nematode species can damage certain turfgrasses throughout North Carolina. If a nematode problem is suspected, soil samples should be assayed to identify the type of nematodes that might be causing the damage. Several methods of turf management may be considered in addition to chemical treatment to help overcome the effect of the nematodes. Contact the Agricultural Extension Service in your county or the Turfgrass Extension Specialists at N. C. State University if you need additional information on nematodes on turfgrasses.

SMALL ENGINE MAINTENANCE

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Preventive Maintenance is the link in the chain of success, that offers you the possibility of increased engine life and economical operation at an overall reduction in cost.

We in the Turf Industry use three types of small engines; the two cycle, four cycle gasoline and four cycle diesel, each having individual characteristics which demands special maintenance,

Two cycle engines are lubricated by mixing oil with the gasoline. The correct ratio of oil to gasoline is very important. Use only regular grade leaded gasoline. Do not use highly leaded, unleaded or low lead gasoline. Follow the ratios recommended by the manufacturer. Special two cycle custom lubricant is usually recommended. If this is not available use a good grade SAE40 two cycle oil at a ratio of 20 - 1. Do not use outboard engine oil because it is designed for water cooled engines. Mix fuel in a clean container equipped with a strainer. Pour half of the gasoline and all of the oil into the container. Shake vigorously! Add the rest of the gasoline and shake again. Thoroughly mixed fuel makes the engine run mutch better. Periodically it is necessary to remove the muffler from two cycle engines and clean carbon deposits from the muffler and exhaust ports. With the muffler removed, rotate the engine until the piston covers the exhaust port completely. Use a wooden or suitable scraper and clean in and around the exhaust port. Use extreme caution not to scratch the piston or break the rings. Turn the engine exhaust side down and blow loose particles away with compressed air. Re-install the muffler. Never operate a two cycle engine without a muffler. Carburetor adjustment is critical on two cycle engines and if done carelessly can damage the engine. Before making any carburetor adjustments, make sure the air filter is clean. A dirty air filter can make the engine operate as though the carburetor needs adjusting. The low speed mixture needle should be adjusted so the engine will accelerate without hesitation or falter. The high speed needle should be adjusted for best power under load. Do not judge by the sound of a two cycle engine, but by the way it pulls.

Use clean, fresh, regular grade of leaded or non-leaded gasoline in four cycle engines. I emphasize FRESH because gasoline can become stale after extended storage and cause gum deposits to form in the fuel system, especially in the carburetor.

Improperly adjusted chokes are a major cause of hard starting. The choke should be checked and adjusted at the first indication of slow starting.

Frequent cleaning of the cooling system on all air cooled engines is extremely important to prevent overheating and overspeeding. Air is drawn through the intake screens into the fan housing by fins on the flywheel and is circulated past cooling fins on the cylinder block and head. The intake screens and cooling fins must be kept clean and unobstructed. Check and clean before each start-up. Periodically it is advisable to remove the blower housing and cylinder shrouds and clean thoroughly. DO NOT operate engine with blower housing, screens or shields removed or missing, as these direct the flow of cooling air and would result in improper circulation and possible engine damage due to overheating.

Dirt induced through poorly serviced or inadequate air cleaners wears out more engines than does many hours of operation. Frequency of air cleaner service should depend on the conditions of operation. When good clean air conditions prevail, service air cleaners at least each fifty hours of operation and replace dry type filters after each 100 to 200 hours. Service and replace more frequent when operating under extremely dirty conditions. Do not wash or use air pressure to clean paper elements. Remove surface dirt by tapping the element lightly on a flat surface. The condition of the element can be best determined by holding it over a ligh bulb. If light cannot be seen through the paper a new element should be installed. Likewise, if small holes of bright light appear in the paper, the element should be replaced. The latter condition is the most serious, since pinholes in the paper allow dirt to enter the engine. Special foam pre-cleaners are available for most dry filters, which slips over the element and prevents most of the dirt from entering. Pre-cleaners should be washed in soap and water daily and thoroughly dried before re-installing. DO NOT oil pre-cleaners. On engines equipped with foam type filters only, wash foam in soap and water each 25 hours of operation and saturate in engine oil. Squeeze foam to distribute and remove excess oil before re-installing.

Several factors can contribute to the overall performance of an ignition system.

Spark plugs should be removed and checked every 100 hours. If the plug has a light tan or gray colored coating and the center electrode is not rounded off, it can be cleaned, re-gapped and re-used. Plugs with chalk white, sooty black deposits , or badly rounded off center electrodes should be replaced. Engine operation is greatly affected by breaker point condition and adjustment. If points become dirty or oxidized they can be cleaned with "600" grit sandpaper, re-gapped and used. Badly pitted or burned points should be replaced. If badly burned breaker points occur too frequently, the condenser should be replaced. Ignition coils do not require servicing on a regular basis. However, they should be kept clean and the terminals kept tight to provide a good electrical connection.

I cannot overemphasize the importance of checking and changing oil and oil filters at regular scheduled intervals. To obtain maximum service life from your engine, you must perform these services on time. Check oil level before each start-up and add as necessary to bring level up to the full mark, but never overfill. On new engines, the oil should be changed after the first 5 hours of operation. Thereafter, every 25 hours on engines WITHOUT oil filters and every 50 hours on engines WITH oil filters. Change the filters at every other oil change (every 100 hours). If extremely dusty conditions prevail, change more frequently. Use high quality detergent type oil SAE30, or SAE10W-30 or SAE10W-40 as good alternates.

For gasoline engines, use oil with API service class "SC", "CC", "SD", or "SE".

For diesel engines, use oil with API service class "CA", "CB", "CC", or "CD". The use of "CB" or higher is recommended. Diesel engines require heavy duty oil.

The quality and condition of fuel used in diesel engines is a very important factor in obtaining satisfactory performance. Use a good grade #2 diesel fuel, clean and free of contamination. Fuel filters must be replaced at frequent intervals. The tolerance between fuel injection parts are extremely small. Never allow dirt, water or air to enter, and never allow the fuel tank to run dry. When air enters from an empty tank into the fuel lines and injector system, hard starting and erratic engine operation will result and purging of the system will be necessary. It is imperative that the fuel systems on diesel engines be serviced properly.

Follow the manufacturer's recommendations for maintenance and operation, and remember that maximum operating and safety results can only be expected if your engine is maintained and operated correctly and for what it is intended to do.

This paper was presented for Mr. Fortenberry by Mr. Robert Hamrick of Porter Brothers, Inc.

PLANT DISEASE UPDATE

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Research was continued on the control of spring dead spot (SDS) of bermudagrass on golf greens. Benomyl at 4, 6 or 8 oz of formulated product was applied on November 1 to an overseeded green that had about 15% of the area affected with SDS in the spring. The 8 oz rate gave complete contol of SDS the following spring. The 4 and 6 oz rates gave 90 and 96% control, respectively, compared to the check. Better winter survival of bermudagrass was observed in some of these treatments at several locations. An application has been submitted for a label to use this chemical for SDS control on bermudagrass in North Carolina.

A graduate student, Mr. Bruce Martin, has recently complete his Ph. D. thesis on Rhizoctonia species that cause brown patch diseases on turfgrasses in North Carolina. He identified three different species of Rhizoctonia that can cause diseases on grasses under different environmental conditions. Rhizoctonia solani was frequently associated with brown patch diseases on cool-season grasses during warm-wet weather and R. cerealis was identified on samples with yellow patch or winter brown patch symptoms. Rhizoctonia zeae, a species not previously reported on turfgrasses, was identified from many locations in North Carolina. This fungus was associated with diseases on cool-season grasses during very hot and dry weather. All these fungi look very similar under the microscope and can be separated only with nuclear staining and cultural techniques. The species differed in their sensitivity to selected fungicides which helps explain some problems of controlling brown patch diseases with some fungicides. Rhizoctonia zeae was not sensitive to very high rates of benomyl. The significance of this information is that it had been assumed that Rhizoctonia solani caused all the brown patch diseses in North Carolina. A cool-weather brown patch disease has been a serious problem during the spring and early summer on hybrid bermudagrass fairways on several golf courses in central North

Carolina for several years. Fungicides have not controlled this disease in several experiments. The bermudagrass has usually recovered in the affected areas by mid-summer.

Southern blight has become a serious disease some bluegrass fairways in western North Carolina. This disease appears as circular dead spots often with some green grass in the centers during hot-wet weather. The fungicide, Bayleton, has given excellent control of this disease with one application.

Large numbers of lance and stubby-root nematodes have been associated with some poor turf areas on some golf greens. Nematicides have not controlled these nematodes satisfactorly, therefore the importance of these nematodes in causing the poor turf has not be demonstrated. Nemacur applied in July or August has given the best control of sting nematodes on bermuda-grass golf greens. Results indicate that treatment may be needed only once every two years if the late summer treatment is used.

The extension program on turfgrass diseases includes the development of the program for the turf-grass conference each year, participation in landscape workshops throughout the state, working with county agents, demonstrations on disease and nematode control, articles for newsletters, diagnosis of more than 200 disease specimens each year and coordination of the pesticide training and recertification program in ornamentals and turf for North Carolina.

WEED MANAGEMENT RESEARCH IN TURF

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In the previous article concerning weed control on greens the use of ethofumesate (Trade name: Prograss) to control annual bluegrass (*Poa annua*) in bermudagrass greens overseeded to perennial ryegrass was discussed. A summary of our observations on annual bluegrass control with Prograss and its effect on spring green-up are given in the following table.

PROGRASS (ethofumesate) FOR *Poa annua* CONTROL IN BERMUDAGRASS OVERSEEDED WITH RYEGRASS

Rate lb ai/A	Appl Time	% Control		Spring green-up of bermudagrass	
		RCC	HGC	RCC	HGC
0	-	0	10	9.5	9.3
1	Nov	96	79	9.8	9.8
2	Nov	100	91	9.0	8.5
1+1	Nov + Dec	100	98	9.0	9.5
2+1	Nov + Dec	98	100	7.8	7.8
2+2	Nov + Dec	100	100	7.8	5.0
1	Dec	48	32	10.0	9.3
2	Dec	58	78	8.8	8.3
1+1	Dec + Feb	92	95	7.3	7.8
2+1	Dec + Feb	100	99	8.0	7.5
2+2	Dec + Feb	99	100	3.0	4.5

RCC: Raleigh Country Club - Nov. 26, Dec. 26, Feb. 26

HGC: Hillandale Golf Course - Nov. 20, Dec. 19, Feb. 20

Spring green-up: 10=normal green, 0=no green-up

All data taken April 29, 1981

Two applications at 1 lb active/A (2 pts/A) per application, with the initial application in November and the second in December, gave the best control with the least effect on spring green-up of the common bermudagrass. Anytime a 2-lb rate was applied or spraying was done in February spring green-up was delayed.

Prograss is not currently labelled for bentgrass. However, BFC Chemical is interested in pursuing this possibility. We have initiated extensive evaluations of Prograss on bentgrass in the state. Different herbicide rates and dates of application are being evaluated. To date established Penncross bentgrass appears to have tolerance to Prograss except where bentgrass roots are very shallow. Test locations are:

Charlotte Country Club
Etowah Country Club
Greensboro Country Club
Pine Needles Country Club
Quail Hollow Country Club
Southern Pines Country Club

In another study conducted with Dr. DiPaola and Dr. Gilbert we are examining the tolerance of overseeded grasses and Tifgreen bermudagrass to Prograss. Our objectives are to evaluate: 1) Tolerance of a) CBS, b) Legend, and c) Legend + Sabre, 2) Tifgreen recovery in the spring, 3) Tifgreen root growth, and 4) Poa annua control.

Rates of Prograss and time of application after overseeding are part of the study.

Other research conducted in 1981 concerned the influence of growth retardants on seed head reduction and turf acceptability of Kentucky 31 tall fescue and Pensacola bahiagrass along highways. This work was also done in cooperation with Dr. DiPaola and Dr. Gilbert and will be continued in 1982.

INSECT CONTROL - 1981

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Raleigh, NC

A few years ago, chlorinated hydrocarbon insecticides such as chlordane, dieldrin and aldrin provided reliable and long lasting control of Japanese beetle larvae and other white grubs in turf. Grubs developed resistance to these materials, and they were not highly effective just prior to the time their use on turf was eliminated by federal restrictions.

As grubs of various beetles became more of a problem in North Carolina, field evaluations of several carbamate and organophosphate insecticides were stepped up. Federal registration of diazinon, Dylox/Proxol and Dursban were received. Also a registration for Sevin for green June beetle grubs was received. With the exception of Dursban, which has been erratic, good control was received when these insecticides were used as directed. However, if a damaging infestation of grubs appeared in the spring, a treatment was needed both then and again in the fall for year long control.

During the period 1978-1981 fifteen different insecticide active ingredients in several different formulations were evaluated in hope of finding a more effective grub control insecticide with a longer residual. Some cutback in field trials was necessary in 1981 due to a six-month Intergovernmental Personnel Act assignment with the United States Department of Agriculture in Washington, DC area. However, one large field trial for Japanese beetle grub control was initiated in 1981 and another was completed. In both tests Oftanol 5% granules at the rate of 2 pounds active ingredient per acre gave better control than diazinon granules at the rate of 5.5 pounds of active ingredient per acre or Dursban at 2.5 pounds of active ingredient per acre. Although control was good with Oftanol with both a fall and spring application, fall applications were somewhat better.

Another insecticide, Turcam (Ficam) 76% wettable powder, was evaluated in earlier tests for control of Japanese beetles and green June beetles.

As a result of these tests, Oftanol 5G and Turcam 76% wettable powder have received registration for control of Japanese beetle grubs and other white grubs. Turcam is also labeled for control of

chinch bugs, sod webworms and leafhoppers. Oftanol is labeled for billbugs, chinch bugs and sod webworms in addition to grubs.

Both insecticides are limited for use by licensed, commercial pesticide applicators. Oftanol 5G should be used at the rate of 40 pounds per acre. Turcam is labeled for white grubs at 1 to 2 ounces per 1,000 square feet. This is equivalent to approximately 2½ to 5 pounds of 76% WP per acre. Rates for sod webworms and leafhoppers are one-half of the above rate.

Oftanol is the trade name for a long residual organophosphate, isofenphos, manufactured and sold by Mobay.

Turcam is the trade name for bendiocarb, a carbamate insecticide manufactured by BFC. It is also sold under the trade name Ficam for use by professional pest control operators for household insect control. The common formulation is a 76% wettable powder.

TURFGRASS CULTIVAR EVALUATIONS

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The evaluation of turfgrass cultivars include ratings for uniformity, density, texture, growth habit, smoothness and color. These vary with the type of grass, time of year, and purpose of use.

The evaluation trials are conducted at the turfgrass field plots, adjacent to the NCSU Faculty Club. The soil is a Cecil gravelly sandy loam (Typic Hapludult), with a high level of available P (47 ppm), a low level of available K (11 ppm), and a pH of 5.8. Preseeding treatments per 1000 square feet were as follows: Dolomitic limestone at 50 pounds worked into the top 6 inches and a 12-4-8 fertilizer (25% of N being urea-formaldehyde) at the rate of 1 pound N mixed into the top 2 inches.

The second Southern Turf Work Group Regional Tall Fescue trial consisted of 19 cultivars seeded October 3, 1978 at 5 pounds seed/M^2. Fertility treatments have been 0.5 pounds N in mid-February from ammonium nitrate, 1.0 pounds N in mid-September and again in mid-November from a complete fertilizer (4-1-2 ratio)

Table 1. Southern Turf Work Group Regional Tall Fescue Test No. 2.

Mean Turfgrass Quality Ratings of Tall Fescue Cultivars

Entry	Year Means			September Mean 1981
	1979	1980	1981	
Rebel	7.7ab	7.2a	6.5a	7.3a
Belt KPH 1	7.4a-d	6.5b-c	5.9b	6.0a-c
Falcon	7.7a-c	6.7a-c	5.8bc	6.0a-c
Ky 31	7.5a-d	6.4b-c	5.7bc	6.3ab
Clemfine	6.9e-f	6.5b-c	5.6b-d	4.7b-e
PHB-1-S	7.2d-e	6.3c-d	5.6b-e	5.0b-e
Galway	7.8a	6.8a-b	5.5b-e	5.7a-d
Kenwell	7.3b-e	6.3c-d	5.4b-e	5.3b-e
Kenmont	7.4a-d	6.3c-d	5.4b-e	5.0b-e
Blend 36-1	7.3b-e	6.3c-d	5.4c-e	5.7a-d
Belt Syn 16-1	7.3b-e	6.1 d-e	5.4c-e	5.0 b-e
Belt TF 11	7.6a-d	6.1d-e	5.1e-f	4.6b-e
Kenhy	7.5a-d	5.8e	5.1e-f	4.7b-e
Belt TF 25	7.6a-d	5.7e	4.8f-g	4.0d-e
AG 125	7.8a	6.0d-e	4.8f-g	3.7e
Alta	7.2d-e	5.2f-g	4.6f-g	4.3c-e
Goar	6.2g	4.8g	4.5g	4.0d-e
Monaco	7.2d-e	4.7g	4.4g	4.0d-e
Fawn	6.7f	4.9g	4.3g	3.7f

Rating 1 - 9, 9 = best. Means with same letter are not significantly different.

The tall fescue cultivar 'Rebel' (T-5) has been the highest rated in both 1980 and 1981, with 'Falcon' (NJ-78), Beltsville KPH-1, and Ky 31 being fairly close. Of interest is the September mean of 1981 which is a reflection of the summer survival. Rebel had the highest rating (7.3) with Ky 31 second with a rating of 6.3.

A number of new tall fescue cultivars have been developed after the regional test was seeded. Since tall fescue is so important in North Carolina, an evaluation trial with 18 new cultivars plus 4 from the regional test was seeded on October 9, 1981. Also, two mixutres of Ky 31 tall fescue plus Kentucky bluegrass were included. All plots were seeded at 5 pounds/M^2 tall fescue. Kenblue Kentucky bluegrass in entry 24 was seeded at 1 pound/M^2 and in entry 25 at 0.5 pound/M^2 each of Kenblue and Glade.

Limited data has been recorded so far.

Table 2. Turf Type Tall Fescue Evaluation

Entry		Source	Entry		Source
1.	Mustang	Pickseed	13.	TF 521	Turf Seed
2.	KS 78-4-1	Scott	14.	TF 579	Turf Seed
3.	KS 76-703-2	Scott	15.	Falcon	Turf Seed
4.	KS 78-347-1	Scott	16.	Clemfine	Lofts
5.	KS 76-701-2	Scott	17.	Rebel	Lofts
6.	TF 805	ISI	18.	Syn. GA	Rutgers
7.	Brookston	ISI	19	Ky 31	Wyatt-Quarles
8.	LS 9	ISI	20.	K5-27	LTL
9.	Houndog	ISI	21.	NK 81452	Northrup King
10.	TF 5LL	Turf Seed	22.	NK 81453	Northrup King
11.	Olympic	Turf Seed	23.	Galway	Northrup King
12.	TF 55B	Turf Seed	24	Ky 31 + Kenblue	
			25.	Ky 31 + Glade + Kenblue	

A national Kentucky bluegrass test was seeded October 14, 1980 with 85 entries. Seeding rate was 2.3 pounds/M^2. This is a cooperative effort with 8 of the Southern Turf Work Group states involved with 27 other states through the coordination of the USDA at Beltsville, Md. The same type data as with the tall fescue test will be collected and analyzed by location and overall. Hopefully, we will have several bluegrasses that will do well in our area.

Table 3 KENTUCKY BLUEGRASS

National Test 1981

Entry	Mean	Entry	Mean	Entry	Mean
CEB VB 3965	7.40 a	Bayside	6.70 b-q	Merit	6.19 n-w
225	7.33 ab	Banff	6.67 c-r	A-34	6.19 n-w
MLM-18011	7.26 a-c	PER PP 300	6.67 c-r	Eclipse	6.19 n-w
WW AG 463	7.22 a-d	WW AG H80	6.63 c-r	K3-162	6.19 n-w
Fylking	7.19 a-e	820-6A	6.63 c-r	Barblue	6.19 n-w
Glade	7.15 a-f	RAM-1	6.59 d-t	TPI 96B	6.19 n-w
Monoply	7.14 a-f	Wabash	6.56 e-t	A20	6.15 n-w
PSU-173	7.11 a-f	Enmundi	6.56 e-t	Lovegreen	6.15 n-w
Mosa	7.04 a-h	Geronimo	6.56 e-t	Trenton	6.11 o-w
Victa	7.07 a-h	Bonnieblue	6.52 f-t	Vantage	6.11 o-w
BA-61-91	7.04 a-i	NJ 735	6.52 f-t	Adelphi	6.07 p-w
Admiral	7.04 a-i	K1-152	6.48 g-u	SV-01617	6.04 q-w
239	7.00 a-j	PSU 190	6.44 h-u	American	6.04 q-w
Touchdown	7.00 a-j	I-13	6.44 h-u	Enoble	6.00 r-x
Escort	7.00 a-j	N535	6.44 h-u	Argyle	5.96 s-x
K3-178	7.00 a-j	Apart	6.41 i-v	S.D. Common	5.93 t-x
Cheri	6.96 a-j	Parade	6.37 j-v	S-21	5.85 u-y
1528T	6.93 a-k	A20-6	6.37 j-v	Cello	5.85 u-y
H7	6.93 a-k	Mona	6.37 j-v	Bristol	5.85 u-y
Baron	6.89 a-l	Birka	6.30 k-v	Merion	5.85 u-y
Nugget	6.85 a-l	SH-2	6.30 k-v	243	5.78 v-y
Shasta	6.85 a-l	PSU-150	6.26 l-v	Kimono	5.78 v-y
Vanessa	6.81 a-l	Welcome	6.26 l-v	Holiday	5.78 v-y
Charlotte	6.78 a-o	Sydsport	6.26 l-v	Piedmont	5.78 v-y
Rugby	6.74 b-p	Mystic	6.26 l-v	MER PP 43	5.78 v-y
Aspen	6.74 b-p	K3-179	6.26 l-v	Kenblue	5.59 w-y
Bono	6.74 b-p	Harmony	6.22 m-w	WW AG 478	5.41 x-y
Columbia	6.70 b-q	Majestic	6.22 m-w	Plush	5.26 y
				Dormie	4.59 z

Rating 1 - 9, 9 = best. Means with same letter are not significantly different.

Selected cultivars of cool season grasses were seeded in heavy shade on November 10, 1980. The seeding rates in pounds per 1000 square feet were as follows: Tall fescue and perennial ryegrass - 6; tall fescue - Ky bluegrass mixture 6:2; fine-leaved fescues - 3; and bluegrass 2.

Of interest is the top rating (6.5) of Ky 31 tall fescue with Kenblue Ky bluegrass. When seeded alone Ky 31 had a yearly mean of 4.0, while Kenblue was next to the bottom with a rating of 3.2. Glade Kentucky bluegrass had the highest September rating, which reflects its summer performance.

It is planned to replant the shade plots in the fall of 1982, using some of the higher performing tall fescues mixed with the higher rated bluegrasses.

Table 4 SHADE EVALUATION

Cool Season Grasses 1981

Entry	Year Mean	Sept. Mean	Entry	Year Mean	Sept. Mean
Ky 31 - Kenblue	5.6 a	6.5 ab	Glade (Ky B)	4.4 e-g	6.9 a
Derby (PR)	5.4 ab	2.8 f	Highlight (CF)	4.2 e-h	5.0 b-e
Falcon (TF)	5.3 ab	5.7 a-c	Banner (CF)	4.0 f-i	3.5 d-f
Ensylva (RF)	5.1 a-c	6.3 a-b	Ky 31 (TF)	4.0 f-i	3.2 e-f
Houndog (TF)	5.0 b-d	5.8 a-c	Galway (TF)	3.9 f-i	4.1 c-f
Sabre (RB)	4.7 c-e	4.7 b-e	Fortress (RF)	3.8 g-i	4.7 b-e
Jamestown (CF)	4.7 c-e	4.0 c-f	Baron (Ky B)	3.8 h-i	5.3 a-d
FL-1 (HF)	4.6 c-e	5.0 b-e	Biljart (HF)	3.7 h-j	4.0 c-f
Clemfine (TF)	4.6 d-e	4.8 b-e	Rebel (TF)	3.6 i-j	3.5 d-f
Olympic (TF)	4.4 e-f	6.0 a-b	Kenblue (Ky B)	3.2 j-k	4.8 b-e
Fylking (Ky B)	4.4 e-f	5.8 a-c	Pennlawn (RF)	3.0 k	3.5 d-f
Ram 1 (Ky B)	4.4 e-g	5.5 a-c			

Rating 1 - 9, 9 = best. Means with same letter are not significantly different.

NCSU TURF PROGRAM UPDATE

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North Carolina's turfgrass industry is a multi-faceted enterprise including many turf interest areas from the intensive culture of golf course greens to the minimum maintenance goals of many roadside turf sites. Turfgrass managers currently spend in excess of 400 million dollars per year in the maintenance of almost one million acres of North Carolina turf. The diverse needs of our state's turf industry are served through several departments within North Carolina State University, including Crop Science, Plant Pathology, Entomology, Horticulture, and Soil Science. The NCSU turfgrass work group is composed of six faculty members from three departments, each with direct turfgrass research, extension, or teaching responsibilities. Members of the turf work group are Drs. Blake, DiPaola, Gilbert, Lewis, Lucas, and Robertson. Turfgrass work group meetings are held monthly for the purpose of ensuring program direction and to facilitate cooperation and assistance within the turf program. Members of the NCSU turf work group also serve as advisors to the Turfgrass Council of North Carolina board of directors.

Turfgrass research programs are underway in a) the control of disease, insect, nematode, and weed pests of turf, b) varietal performance evaluations, c) environmental stress tolerance, i.e. cold hardiness, shade tolerance, and water stress, d) root growth and development, e) low maintenance turf management, and f) turfgrass fertilization. A principle tool of the turf work group in the persuit of these endeavors is the NCSU turfgrass field plots. Much effort has been directed towards the expansion and development of this facility. All of the major turfgrass species utilized in North Carolina are currently maintained within the 8.5 acres of the turfgrass field plots.

The turfgrass field plots include over 50,000 square feet of experimental putting greens, roadside evaluation trials, pesticide phytotoxicity test areas, cultivar evaluations, and shade tolerance trials. Automatic irrigation has been installed in many areas and has an estimated completed value of $ 65,000. This system was made affordable by the 75 % discount on irrigation equipment extended by the Toro Company as service through E. J. Smith and Sons.

The turfgrass field plots are supported from a small shop located nearby. A larger maintenance shop is a priority need in order to adequately service and store the many different types of turf equipment and supplies. The newly initiated turfgrass research and extension fund was established in part, to assist in providing the funds necessary for a maintenance shop facility. Many of the items necessary for the maintenance of the turf field plots are donated or loaned for use in the turfgrass program. Those who have been so generous with material and/or financial support of the turf

program at NCSU are acknowledged in the Turf Field Day/Exhibit Field Tour Summaries booklet. The loan of a Toro Greensmaster III greensmower by E.J. Smith and Sons and a Jacobsen TurfCat by Porter Brothers, Inc. has been of particular assistance in the care and maintenance of the turf field plots at NCSU.

The turfgrass field plots and campus laboratory facilities are essential tools needed by the NCSU turfgrass work group in its effort to seek new information and improved ways of managing turf. Extension service turf newsletters, leaflets, circulars, and Teletips are ready sources of turf information. Demonstration and research plots located throughout North Carolina are open to the public for inspection. The annual Turfgrass Conference, Field Day, and workshops are additional opportunities for communication between NCSU turfgrass personnel and the turfgrass industry.

Turfgrass Management and Physiology Investigations in Progress include:

1. The influence of syringing on the leaf temperature of bentgrass golf greens. (Carolinas Golf Association Supported)

2. Seasonal changes in the cold tolerance of bermudagrass turf. (Carolinas Golf Association Supported)

3. Shade tolerance of selected cool season turfgrasses.*

4 The utilization of wetting agents and cultural practices in the treatment and prevention of localized dry spots on fine turf.*

5. Evaluation of winter overseeding cultivars for golf greens, tees, collars, and home lawns.*

6. The adaptation of selected plant species along North Carolina's roadsides.*#

7. Physiographic zoning of North Carolina.*#

8. Low maintenance turf establishment.*#

9. The influence of cultural practices and fertilization on the spring rooting of bermudagrass turf.

10. The tolerance of bermudagrass and overseeded turf to varying rates and dates of application of ethofumesate (Prograss 4F).**

11. Influence of fertilizer type and rate on the utilization of selected growth retardants on tall fescue.**#

12. Evaluation of selected growth retardants for use on tall fescue and bahiagrass roadside turf.**#

13. The influence of selected plant growth regulators on the growth, quality, recuperative potential, root growth, and cold tolerance of common bermudagrass.

14. The evaluation of maleic hydrazide effectiveness following application at various stages of seedhead development.**

* Cooperative study with W.B. Gilbert.

** Cooperative study with W.B. Gilbert and W.M. Lewis.

Federal and State Dept. of Transportation Supported.

THE TURFGRASS COUNCIL OF NORTH CAROLINA, INC.

The Turfgrass Council of North Carolina is a Non-Stock Association incorporated under the laws of the State of North Carolina and is tax-exempt.

PURPOSES AND OBJECTIVES

The purposes of the Turfgrass Council are: (1) to promote the Turfgrass industry; (2) to encourage further study and research in turfgrasses; (3) to analyze and disseminate information relating to turfgrasses; (4) to represent the turfgrass industry in matters of policy. The objective of the Turfgrass Council is to help obtain the best turf possible for lawns, golf courses, athletic fields, parks, cemeteries, and roadsides throughout North Carolina.

ACTIVITIES

The Annual North Carolina Turfgrass Conference is sponsored by the Turfgrass Council and North Carolina State University. A newsletter is published by the Turfgrass Council to inform its membership of its activities and turf related programs in the state. Turfgrass research and scholarship programs in North Carolina receive financial and commodity support from the Turfgrass Council. A turfgrass Research and Extension Fund has been established with the Agricultural Foundation at N.C. State University to obtain additional funds for research and extension programs on turfgrasses.

MEMBERSHIP

Memberships are available to individuals interested in turfgrasses, representatives from turf-related organizations, and sales representatives. for $10 per year. The Turfgrass Council encourages all persons engaged in any phase of the Turfgrass Industry in North Carolina to become members to help promote extension, research, and educational programs on turfgrasses.

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