PROCEEDINGS
OF THE
26TH ANNUAL NORTH CAROLINA
TURFGRASS CONFERENCE

Volume IX

January 6-8, 1988

Winston-Salem, North Carolina

Sponsored by

Turfgrass Council of North Carolina

North Carolina State University

North Carolina Agricultural Extension Service

PREFACE

Proceedings of the 26th Annual North Carolina Turfgrass Conference are being provided as a permanent reference to those who attended the Conference. The 1988 Conference was held at the Benton Convention Center in Winston-Salem, NC, on January 6, 7, and 8. Sessions with general turf topics and concurrent sessions for golf course, lawn care, roadside and low maintenance turf, landscape maintenance, sod, and athletic field topics were scheduled. Workshops on Athletic Field Maintenance, Turf Nutrition and Fertilizers, and Soil Physical Properties and Diagnosis of Insect and Disease Problems were held the afternoon of January 6. The trade show used 40,000 square feet of space. Approximately 1100 people attended the Conference.

Special thanks are extended to everyone who helped make this Conference successful. Each speaker is to be commended for his excellent presentation. The Annual Turfgrass Conference was sponsored by the Turfgrass Council of North Carolina, Inc., North Carolina State University, The North Carolina Agricultural Extension Service, and the Piedmont Turfgrass Association. The following committee members contributed to the success of the Conference.

CONFERENCE COMMITTEE - Art Bruneau, Chairman

Les Kuykendall	George Thompson	Leon Lucas
Bill Riggan	Charles Tomlinson	Gene Crews
Ray Avery	Bob Bell	

PROGRAM COMMITTEE - Leon Lucas, Chairman

Fred Biggers	Art Bruneau	Jack Cox
Joe DiPaola	Bill Johnson	Charles Tomlinson
Fred Miller	Kim Powell	Les Kuykendall
Charles Fierke	George Thompson	Bob Tumey
Tom Gravitte		

TRADE SHOW COMMITTEE - Bill Riggan, Chairman

Larry Baker	Gary Stafford	Jim Welch
Ed Ancherico	Gary Randolph	R. L. Robertson
Bob Bell	P. J. Lenihan	

LOCAL ARRANGEMENTS COMMITTEE - Gene Crews, Chairman

Chuck Dolge	Rick Briley	Sam Linker
Ray Avery		

PROCEEDINGS EDITORS: L. T. Lucas and A. H. Bruneau, Extension Plant Pathology Specialist-Turf, and Extension Crop Science Specialist - Turf, respectively, North Carolina State University, Raleigh, NC 27695.

Printed December 1988

The 1989 North Carolina Turfgrass Conference will be held in Raleigh, NC on January 4, 5, and 6.

Additional copies of the Proceedings are available at $5.00 each from Dr. L. T. Lucas, Department of Plant Pathology, Box 7616, North Carolina State University, Raleigh, NC 27695-7616. Make checks payable to the Turfgrass Council of North Carolina.

TABLE OF CONTENTS

TURFGRASS VARIETIES - WHAT'S ON THE HORIZON

C. Reed Funk
New Jersey Agricultural Experiment Station
Cook College
Rutgers University
New Brunswick, New Jersey 08903

The development of landmark varieties such as 'Merion', 'Manhattan', 'Pennfine', 'Rebel', 'Biljart', 'Jamestown', 'Raleigh', 'Bighorn', 'Penncross', 'Tifgreen', and 'Meyer' has benefitted the turfgrass industry and stimulated additional research and genetic improvement programs in many of our important turfgrass species.

Characteristics desired in improved turfgrass varieties include: ease and economy of establishment, dependability, persistence, durability, reduced maintenance costs, and attractive appearance. Each of these can be enhanced as we (1) improve resistance to diseases, insects, nematodes and weed invasion, (2) develop lower-growing grasses with better turf-forming attributes, and (3) increase tolerance of various environmental stresses such as heat, cold, and drought. Turfgrasses with improved tolerance of shade, close mowing, excessive wear, and poor soils can be very useful for specific purposes.

Ease and Economy of Establishment

Continued genetic and agronomic improvements in seed yield is making high quality seed of superior varieties the greatest bargain available in the turfgrass industry. Rapid germination and good seedling vigor are largely responsible for the rapid acceptance and widespread use of the improved, turf-type varieties of perennial ryegrass. A better understanding is needed of the role of after-ripening dormancy of newly harvested seed. Such seed germinates well if night temperatures are cool during establishment but poorly if temperatures are high. Older seed that has lost its post-harvest dormancy will germinate well under a wider range of temperatures.

Pest Resistance

Plant breeding frequently makes its greatest

contributions in the development of varieties with improved resistance to important disease, insect, and nematode problems. Present and prospective restrictions on the use of pesticides makes genetic resistance of even greater importance. Turfgrasses undamaged by disease and insects are more tolerant of environmental stresses, more resistant to weed invasion and less damaged by heavy use. Substantial progress is being made in the development of varieties with improved resistance to important turfgrass diseases. An excellent example is the development of numerous varieties of Kentucky bluegrass with good resistance to the Helminthosporium leaf spot and melting-out disease. However, the existence of numerous physiological races in many of the rusts, smuts, and powdery mildews makes it necessary to continually search for more stable sources of non-race-specific types of resistance. Programs to increase disease resistance will continue to be a very important part of all turfgrass breeding programs. Future plant breeders may benefit from a better understanding and possible utilization of non-host immunity. The most common host-pathogen relationship is that of immunity of the host and avirulence of the pathogen. Rust from ryegrass does not attack potatoes and Kentucky bluegrass does not suffer from malaria. Of the countless thousands of pathogens, each host species is susceptible to only a relatively small number. Information on the molecular genetics of host-pathogen relationships may enable us to eventually transfer genetic factors conditioning immunity among distantly related species.

Only limited efforts have been made to improve resistance to insects and parasitic nematodes. Insects are causing increased damage on many turf areas. This is partly due to the reduced availability or effectiveness of many insecticides. Tall fescue has generally better insect resistant than other cool-season turfgrass species. This insect resistance is one of the reasons for the widespread interest in developing more attractive varieties of this important turfgrass species. Useful strains of endophytic fungi can frequently enhance genetic resistance to many, but not all, harmful turfgrass insects.

Herbicide Tolerance

The development of turfgrass varieties with excellent tolerance of highly effective herbicides

would improve our ability to selectively control many difficult weeds. Certain zoysiagrass varieties, including 'Meyer' are highly tolerant of atrazine and simazine. Others, including 'Midwest" are rather sensitive (Engel et al., 1968). This tolerance permits the use of these highly effective herbicides to selectively control many weeds troublesome in the establishment and maintenance of zoysiagrass. Using conventional breeding procedures, researchers in Northern Ireland have developed varieties of bentgrass and fine fescue with increased herbicide tolerance (Fisher and Wright, 1980). Use of molecular genetics will make such programs even more effective. We should be able to eventually remove Poa annua effectively from greens and fairways planted with a herbicide resistant bentgrass variety.

Wear Tolerance

A turfgrass variety exhibits its best wear tolerance under conditions where it is best adapted. Wear tolerance is reduced by diseases, insects, poor management, shade or other unfavorable environmental conditions. The improved bermudagrasses have excellent wear tolerance and recuperative ability during warm favorable growing conditions. The improved turf-type perennial ryegrasses have shown good wear tolerance under cool temperatures. They have a low crown, a tough leaf and moderate recuperative ability. Areas receiving excessive wear benefit from timely overseeding. Combinations of bermudagrass-perennial ryegrass will receive even greater popularity for turfs receiving maximum use.

Salt Tolerance

Turfgrass managers troubled by road salt, ocean spray, or saline soils should benefit from more salt tolerant species and varieties. Puccinnella distans commonly referred to as salt-marsh-grass in Europe is a perennial, moderately low-growing bunchgrass with a high tolerance of saline and alkaline soils. Improved varieties such as 'Fults' are winterhardy, cool-season grasses that will produce a dense, dark green turf on salty soils. However, they are weak and normally crowded out by other species where salt is not present. Varieties of slender creeping red fescue, including 'Dawson' and 'Golfrood' show good salt tolerance. 'Seaside' creeping bentgrass and many tall fescues show moderate salt tolerance.

Two new warm-season turfgrasses, 'Adalayd' and 'Futurf' have shown good salt tolerance in southern California. These varieties of Paspalum vaginatum were collected in Australia. Dr. Milton Engelke and Jack Murray collected zoysiagrasses with exceptional salt tolerance from coastal regions of Korea.

Improved Performance on Problem Soils

'Merlin' slender creeping red fescue is tolerant of high amounts of lead and zinc. It was developed from plants selected from an old mine tip. Research by Murray and Foy at Beltsville, Maryland show substantial differences exist in tolerance of acid soils among selections of tall fescue, fine fescues and Kentucky bluegrasses. Improved varieties of hard fescue and blue sheeps fescue have been developed which are capable of producing a fine textured, dense, persistent, low-growing turf with little or no applied fertilizer following establishment. Zoysiagrasses are available that will produce an excellent warm-season turf on poor soils with no supplemental fertilization.

Heat and Drought Tolerance

Current research being sponsored by the United States Golf Association and the Golf Course Superintendents Association should lead to significant savings in irrigation water and result in improved turf. Use of grass species with greater drought tolerance and lower water use requirements will be necessary in many areas where water will become less available for turf use. We will also see increased emphasis on the breeding and development of turfgrass varieties that combine improved heat and drought tolerance with increased resistance to summer diseases, insects and nematodes. An effective turfgrass breeding program located in the southeastern section of the United States would be very useful in the development of turfgrasses well adapted to the region.

Shade Tolerance

Development and use of varieties with improved adaptation to shaded environments is an urgent need of the turfgrass industry. The fine fescue are very useful for cool, dry shade in temperate regions. They possess the ability to tolerate tree root competition and the acid, infertile soil conditions associated with many shaded areas. They are, however, very intolerant of poor drainage and high levels of

nitrogen fertilizer during hot weather. A number of Kentucky bluegrasses including 'Bristol', 'Eclipse', 'Glade', and 'Warren's A-34' have improved tolerance of moderate shade in their area of adaptation. The improved turf-type perennial ryegrasses are often useful for temporary turf in heavy shade. Their rapid establishment makes it possible to establish a turf before trees are in full leaf. They can also perform well as a component of the permanent turf in light to moderate shade. The improved turf-type tall fescues have moderate to good shade tolerance. Some of the new "dwarf-types" may well show even better performance in shade.

Rough bluegrass, Poa trivialis, is perhaps our most shade tolerant species, but it requires a cool, moist environment. It is not tolerant of heat and drought and is not compatible with tall fescue, Kentucky bluegrass, fine fescue, or perennial ryegrass mixtures in full sun. 'Sabre', Laser', and 'Colt' are improved varieties with a somewhat darker green color, greater density and a reduced rate of vertical growth. These improved types are useful as specialty grasses for the winter overseeding of dormant warm season turfs and for specialty turf use under cool, moist shade in temperate climates.

Reduced Mowing Requirement

The fine-textured, low-growing, turf-type bermudagrasses developed by Dr. Glenn Burton and others demonstrate the profound changes that can be made in the growth characteristics of a species. Turfgrass varieties with a lower growth profile, a reduced fertilizer requirement, the absence of seed heads, and the ability to resist weed invasion will require less mowing. Recurrent cycles of phenotypic assortive mating are producing lower-growing, "dwarf-type" varieties of Kentucky bluegrass, perennial ryegrass,fine fescue and tall fescue. Varieties with deeper crowns, a lower leaf canopy and reduced mature plant height are being developed. "Dwarf-type" varieties must have good stress tolerance, excellent pest resistance, acceptable seed yield, and good establishment vigor. Continued genetic improvements in all desirable turfgrass attributes will make "dwarf" varieties of great value to the turfgrass industry.

Outlook

The future will bring us new turfgrass varieties vastly superior to those presently available. It will take time, resources, work, dedication and skill. Fortunately, we have a number of talented and hard working people contributing to this effort. Bright young students with excellent training, enthusiasm, a love of turf, and a will to succeed should make this a much better world for all who enjoy and appreciate good turf.

References

1. Burton, G. W. 1969. Improving turfgrasses. p. 410-424. In A. A. Hanson and F. V. Juska (ed.), Turfgrass Science. Monograph Series 14, American Society of Agronomy, Madison, Wisconsin.

2. Engel, R. E., C. R. Funk, and D. A. Kinney. 1968. Effect of varied rates of atrazine and simazine on establishment of several Zoysia strains. Agronomy Journal 60:261-262.

3. Fisher, R., and C. E. Wright. 1980. The breeding of lines of Agrostis tenuis Sibth. and Festuca rubra L. tolerant of grass-killing herbicides. p. 165-171. In J. B. Beard (ed.), Proceedings 3rd International Turfgrass Research Conference, Munich, West Germany. July 1977. American Society of Agronomy, Madison, Wisconsin.

MANAGEMENT PRACTICES FOR ROOT GROWTH

Charles H. Peacock
Associate Professor
North Carolina State University

Eight factors limit plant growth. Of these, seven directly affect the root system. Of these seven, four are directly related to the cultural practices used by the turf manager. Moisture, nutrients, oxygen levels and traffic are all managed, or mismanaged, to affect turf growth and therefore performance.

Roots function to absorb water and nutrients needed by the plant, to anchor the plant and stabilize the soil, and, to a limited extent in grasses, as nutrient storage organs. The root system of grasses is of two types. Seminal or seed roots usually die the first year as they are replaced by adventitious or nodal roots. These are very fibrous and multibranching in nature. Root initiation and growth is seasonal with the cool-season grasses developing roots in spring, and to a lesser extent in the fall and the warm-season grasses developing them in the summer. The size and extent of the root system varies with the cool-season grasses having a more fine textured root system of limited depth while the warm-season grass roots are larger and extend to a greater rooting depth. Root growth, function, and longevity are all affected by plant, soil, environmental interactions. Management must adjust to these interactions in order to grow a strong, healthy root system.

Root characteristics are altered by the cultural practices including mowing, fertilization, irrigation and cultivation and by the type of use. Rooting is reduced by mowing at low heights or excessive frequency, by fertilizing at high nitrogen rates, when there is a potassium deficiency or if excessive thatch is allowed to accumulate. Mowing reduces carbohydrates which directly reduces the extent of the root system. Mowing also stimulates new shoot growth at the expense of the root system. Carbohydrate supplies to the root are slowed or even stopped and roots may even be lost under stringent or irregular mowing regimes. Low mowing reduces root diameter, the number of root hairs and the root initiation rate. It not only affects carbohydrate availability but also may affect root growth regulators. Research studies have shown that when no more than 40% of the topgrowth is removed at one time root growth is slowed but not stopped.

Soil aeration is critical to developing and maintaining a good root system. Irrigation frequency and volume will directly affect root growth by providing the necessary moisture levels for plant growth but also by influencing the amount of soil pore space which is filled by water instead of air. Poor drainage or overwatering will lower the oxygen diffusion rate and create anaerobic conditions which affect root function and viability. Flooded waterlogged turf is injured by indirect effects on soil

aeration. Soil oxygen and carbon dioxide levels restrict root growth. Damage to the root system can occur within 12 to 24 hours and recovery time can be days or even weeks depending on management and environmental conditions. The ratio of soil oxygen:carbon dioxide will affect rooting with the root system favoring a high ratio, more oxygen. There is an implication here that soils high in organic content will proportionally have a greater root mass nearer the surface where there is better gas exchange and a higher oxygen:carbon dioxide ratio. Cultivation can improve gas exchange and greatly alter the turfs ability to have deeper rooting. Edaphic factors influence soil aeration and root zone modification can be important in maintaining a quality turf if natural conditions will limit oxygen diffusion rates.

The primary objective in root zone modification is to minimize problems from intense traffic. The characteristics desired for a modified root zone include the following:

- minimum compaction tendency
- good soil water infiltration and percolation rates
- adequate aeration for deep rooting
- adequate nutrient and water retention

The USGA Green Section method for soil modification is based on a perched water table concept where soil layers of differing particle sizes allows the root zone layer to hold water under capillary tension until there is enough hydraulic head to force this water out of the pores and completely through the soil profile. The USGA Green Section specifications are as follows:

- minimum infiltration capacity of 2 inches per hour for bermudagrass and 3 inches per hour for bentgrass, with 4 to 6 inches per hour preferred
- total porosity between 40 and 55% with not less than 15% aeration porosity
- bulk density between 1.25 and 1.45 g/cc
- water retention between 12 and 25%

A root zone soil mix to meet these specifications must be based on research data from a physical soil testing laboratory. The appropriate sand-soil-organic matter ratio can only be determined based on these tests which are carried out under a variety of conditions to determine the physical and chemical characteristics of the individual components. A general sand-soil-organic matter ratio recommendation CANNOT be made. The particle sizes of "sand" and characteristics of the organic matter can vary too widely. Root zone modifications will improve compaction tendency, improve soil aeration, infiltration and percolation, but may sacrifice nutrient and water retention.

Turf root systems exhibit seasonal growth. Spring root decline or dieback is a phenomenon recently noticed on warm-season turfgrasses. It was known to occur on other perennial species. Since 1977 it has been observed on turfgrasses under

specific environmental conditions. Those years when there are cold winter temperatures and normal or rapid spring greenup or spring shoot growth have experienced the dieback. At this time which has occurred approximately in mid-March the root system dies and must be completely regenerated. At this time the plant is subject to moisture stress and fertilization will not be effective since root surface area is greatly reduced. Within approximately three weeks a new root system is regenerated and active growth is normal.

Soil properties directly affect rooting. There can be mechanical resistance to root growth. Soil particle size, lack of aggregation or soil compaction can greatly reduce rooting. Decreasing porosity or increasing bulk density will decrease root growth. Management practices which relieve and prevent soil compaction are essential in areas subject to heavy traffic.

Root growth directly affects turf stress tolerance. The depth of the root system, root number, and root extension rate all influence drought tolerance. A number of factors restrict rooting including the following:

- excessively high soil temperatures
- acidic soils below pH 5.0
- lack of soil oxygen
- presence of toxic pesticides or salts

Soil moisture levels also will turf rooting since roots do not grow through dry soil layers.

Nutrient uptake is affected by the depth and extent of the root system and the energy available for root respiration. Soil acidity is probably related more to aluminum toxicity rather than to a direct affect of soil pH. Nitrogen levels favor topgrowth which creates greater shading of lower leaves. High nitrogen levels also increase auxin levels, which may inhibit root growth. Phosphorus availability increases photosynthesis which indirectly favors root growth. Phosphorus availability also causes an increase in numbers of root hairs, and branching which directly affects water uptake. Potassium increases root development, particularly branching, which affects drought tolerance. Calcium enhances root growth, particularly root hair development.

Thatch accumulation can greatly affect root development. A thick thatch layer means the roots are more prone to desiccation, greater extremes in temperature and scalping of the shoots which will affect carbohydrate production.

Pest and pesticide factors also can influence the turf root system. Nematodes can have a very damaging effect on turf roots and create a situation where the grass cannot tolerate stress conditions. Applications of certain herbicides will also adversely affect root growth and can create stress conditions for the plant. Preemergent herbicides can significantly affect root

growth. Oxadiazon has been found to have the least effect on the root system followed by bensulide, pendimethalin and oryzalin.

In summary, all cultural practices affect root growth. No one is more or less important than the other. Maintaining adequate mowing height and frequency, keeping soil nutrient and moisture levels at an optimum, cultivating to relieve compaction and keep soil aeration in a favorable oxygen balance and, within budgetary constraints, protecting the root system from pest problems are all critical to favor root growth and plant growth and even survival.

DEVELOPING TURFGRASSES WITH ENDOPHYTE-ENHANCED PERFORMANCE

C. Reed Funk

New Jersey Agricultural Experiment Station, Cook College, Rutgers University, New Brunswick, New Jersey 08903

Recent studies show that endophytic fungi have considerable biological and economic significance (9). Botanists have been aware of endophytic fungi growing systematically within plant tissues for over a century. However, it was not until 1977 that Charles Bacon and his associates at Athens, Georgia recognized that an Acremonium endophyte was associated with certain maladies of cattle grazing tall fescue pastures, especially during hot, dry weather (2). This endophyte is widely distributed and is present in most tall fescue pastures. Nearly 65 percent of all tall fescue plants sampled were infected according to extensive surveys made in Kentucky, Missouri, and Alabama. Growing endophyte-free tall fescue pastures will be of great benefit to the livestock industry. Shortly after Bacon's discovery, scientists in New Zealand observed that ryegrasses infected with a closely related Acremonium endophyte could cause a problem in sheep referred to as "ryegrass staggers" (4). This malady was most likely to occur during periods of overgrazing endophyte-infected ryegrass pastures during hot dry weather. Subsequently, New Zealand scientists discovered an association of the Acremonium endophyte in perennial ryegrass with resistance to the Argentine stem weevil (7). This billbug-like insect is a serious pest of many turf and pasture grasses in New Zealand and some other countries of the southern hemisphere. Thus, New Zealand farmers are faced with a dilemma. Ryegrass pastures without endophyte are devastated by insects, and pastures with endophyte need careful management during periods of heat and drought stress to prevent ryegrass staggers.

Turfgrass scientists in both New Zealand and the United States soon discovered dramatic instances of improved insect resistance, increased persistence, and better performance in endophyte-containing turfs of perennial ryegrass, tall fescue, hard fescue and Chewings fescue. Thus, the Acremonium endophyte may be considered a desirable attribute in grasses grown

specifically for turf and conservation purposes. Field resistance has been observed against billbugs (Sphenophorus spp.), chinch bugs (Blissus leucopterous hirtus), and a number of lepidopterous species of sod webworm (1, 5, 6 and 8). Improved vigor, persistence, stress tolerance, resistance to weed invasion, and enhanced fall recovery have also been observed in perennial ryegrass, tall fescue, hard fescue, and Chewings fescue turfs containing high percentages of endophyte-infected plants (5). We have also observed an increase in the percentage of endophyte-infected plants in old turfs. This is apparently the result of endophyte-free plants being gradually crowded-out and replaced by endophyte-containing grasses exhibiting improved insect resistance and greater stress tolerance. Ellis reported enhanced root growth and modifications in water relations of endophyte-infected ryegrass plants under certain conditions (3). Much additional research is needed to understand the physiological mechanisms conditioning these occasional instances of improved stress tolerance and root production.

To date, we have not observed any adverse effects of endophytes on turfgrass performance. Endophytes appear to have little if any effect on turf performance when conditions are favorable. The endophyte-free ryegrasses 'Gator' and 'Tara' have performed well in a four year National testing program. Observations of endophyte-enhanced performance have normally occurred under conditions of severe stress or attacks by some, but not all, insect pests. Thus turfgrass endophytes may be similiar to insurance, of little value when everything is favorable but of great value under certain conditions of biological and/or environmental stress.

Significant genetic variation exists among endophytes of the same species. Some endophytes may be much more useful than others in enhancing turf performance. We have identified a substantial number of plants with various biotypes of Acremonium endophytes in perennial ryegrass, tall fescue, hard fescue, Chewings fescue, strong creeping red fescue, and blue fescue (8). Attempts are being made to find useful endophytes in Kentucky bluegrass and closely related species of Poa . Such endophytes may hope-

fully be inoculated into our leading apomictic cultivars of Kentucky bluegrass. An estimated 10 million pounds of turf-type perennial ryegrass seed containing a high percentage of endophyte was harvested in 1987. Perennial ryegrass cultivars currently containing at least some seed lots with over 70 percent Acremonium endophyte include 'Regal', 'Pennant', 'All*Star', 'Repell', 'Omega II', 'Citation' II', 'Dasher II', '246', 'SR-4000', and 'SR-4100'. Additional high endophyte perennial ryegrasses will be available after the 1988 seed harvest. They will include 'Commander', 'Pinnacle', 'Sherwood', and 'Dandy'. Turfgrass breeding programs at Seed Research of Oregon, Pure-Seed Testing, Pickseed West, E. F. Burlingham, Rutgers University, and the University of Rhode Island are attempting to develop improved cultivars of hard fescue and Chewings fescue with high levels of useful endophytes. Commercial seed production of 'SR-3000', a high endophyte hard fescue, has been initiated. Development of turf-type tall fescues with high levels of useful endophytes is under consideration.

Turfgrass managers desiring the benefits of endophyte-enhanced turfgrass performance must be careful in their seed selection. Endophyte viability will decline during seed storage, especially under hot, humid conditions. Seed harvested in June or July should maintain a high level of viable endophyte for seedings made during the autumn and following spring if stored under normal good cool, dry conditions. At present, seedlings from a grow-out test must be examined to determine viability of the endophyte in older seed. This can be done by either microscopic examination of properly stained plant tissues or by an ELISA test conducted by well trained laboratory technicians. A number of states are currently offering this service. An appropriate dated seed label showing percent viable endophyte would be useful. It is also important to recognize that different seed lots of the same variety may vary in endophyte level. Normal fungicide applications made to growing turfs should have little or no effect in reducing the level of endophyte.

An increased knowledge of the role of endophytes in modifying turfgrass performance is making cultivar evaluation and breeding programs more efficient.

Turfgrass breeders can be more effective in selecting for non-endophytic or genetic sources of pest resistance and stress tolerance. Specific useful endophytes can subsequently be incorporated using conventional breeding techniques to further enhance turfgrass performance, stress tolerance, and pest resistance. It is also likely that scientists using the newer technologies of molecular biology will be able to modify and select endophytes with more of the desirable characteristics and fewer of the undesirable attributes occurring in present types. This should be of great value to all of us who grow and enjoy good turf.

References

1. Ahmad, S., Johnson-Cicalese J. M., Dickson, W. K., and Funk, C. R. 1986. Endophyte-enhanced resistance in perennial ryegrass to the bluegrass billbug. Sphenophorus parvulus. Entomol. exp. appl. 41:3-10.

2. Bacon, C. W., Porter, J. K., Robbins, J. D., and Luttrell, E. S. 1977. Epichloe typhina from toxic tall fescue grasses. Appl. Environ. Microbiol. 34:576-581.

3. Ellis, D. A. 1987. Effect of Acremonium loliae infection on water relations in perennial ryegrass. Master's Thesis, Rutgers University.

4. Fletcher, L. R. and Harvey, R. C. 1981. An association of a Lolium endophyte with ryegrass staggers. N. Z. Vet. J. 29:185-186.

5. Funk, C. R., Halisky, P. M., Ahmad, S., and Hurley, R. H. 1985. How endophytes modify turfgrass performance and response to insect pests in turfgrass breeding and evaluation trials. Pages 137-145 in: Proc. 5th Int. Turf Res. Conf., F. Lemaire, ed. Avignon, France.

6. Funk, C. R., Halisky, P. M., Johnson, M. C., Siegel, M. R., Stewart, A. V., Ahmad, S., Hurley, R. H., and Harvey, I. C. 1983. An endophytic fungus and resistance to sod webworms: Association in Lolium perenne L. Bio/Technol. 1:189-191.

7. Prestidge, R. A., Pottinger, R. P., and Barker, G. M. 1982. An association of Lolium endophyte with ryegrass resistance to Argentine stem weevil. Pages 119-122 in: Proc. 35th N. Z. Weed Pest Control Conf.

8. Saha, D. C., Johnson-Cicalese, J. M.., Halisky, P. M., van Heemstra, M. I., and Funk, C. R. 1987. Occurrence and significance of endophytic fungi in the fine fescues. Plant Disease 71:1021-1024.

9. Siegel, M. R., Latch, G. C. M., and Johnson, M. C. 1985. Acremonium fungal endophytes of tall fescue and perennial ryegrass: significance and control. Plant Disease 69:179-183.

BLENDS VERSUS AMMONIATED FERTILIZERS

W. S. Howell
Wilmington Fertilizer Company
Wilmington, NC

This article will help you understand how ammoniated and blended fertilizers are manufactured and the basic difference between the two. This information may help you decide which type of fertilizer you would want to use.

The following steps are followed in making a blended 10-10-10 fertilizer. Granular materials are placed into a six-compartment "cluster hopper" on what is called a "batch hopper". From the cluster hopper, 580 pounds of ammonium sulfate (21-00-00-24S) is weighed and fed into the batch hopper. The ammonium sulfate contains 21% N and 24% S. Then 435 pounds of 18-46-00, containing 18% N and 46% triple super phosphate and 1.4% S, and 333 pounds of 00-00-60 muriate of potash are added. The last ingredient to be added is the filler (652 pounds), which is "rock limestone". It contains Ca and Mg, but in the granular form, which could take an indefinite period of time to break down so it can be utilized by the plant.

After all the above materials are in the batch hopper, they are then emptied upon a conveyor belt and carried into the blender. The blender is a 10' x 12' cylinder similar to a cement mixer. The mixing process usually takes about 8-10 minutes. the blender is then reversed and the blended materials exit from the top onto a conveyor belt to either a bulk storage bin or bulk truck. Up to 50 tons of fertilizer can be made per hour with the type blender used by Wilmington Fertilizer Company. In the finished 10-10-10 product, each plant food pellet is separate. When it is applied, broadcast or in the drill, it has a tendency for the plant foods to separate due to size and weight density. This is not as bad as in the past due to more uniform particle size, but in most cases it is still evident.

When a customer buys a bag of 10-10-10 and there are only three (3) plant foods guaranteed on the bag, in most instances the product inside is a blend. The difference in cost between the blend and ammoniated fertilizer is not as wide as a few years ago because the cost of materials used in both blends and ammoniated has increased. The cost difference will range about $8-$10 per ton for 1988; however, blends will continue to be the cheaper of the two.

The following steps are followed in making an ammoniated 10-10-10 fertilizer. Materials being used are not of the granular grades and are placed into a "batch hopper" at the following rates: 336 pounds of standard muriate of potash (00-00-60), 628 pounds of standard ammonium sulfate (21-00-00-24S), 286 pounds of powdered monoammonium phosphate (10-50-00), 321 pounds of powdered normal superphosphate (18.75%

(contains 12% S and 0.5% Mg), 81 pounds of powdered dolomitic lime (contains 21.4% Ca and 21% Mg), and 254 pounds of calcitic lime (contains 42% Ca).

After the above materials are weighed and placed into the batch hopper, they are emptied onto a conveyor belt and conveyed into a 7' x 14' ammoniator (shaped like a cylinder). The ammoniator has four sparging tubes running through it containing each of the following: 93 pounds of a 440 nitrogen solution (24% of which is free ammonia and 69.8% ammonium nitrate), 318 pounds of steam, 4 pounds of H_2O, and 42 pounds of 77% sulfuric acid solution. It takes 3 pounds of superphosphate to absorb 1 pound of free ammonia.

The dry materials mix with the liquids while the ammoniator is turning, thus forming a slurry which empties into a 7' x 40' dryer. The dryer is a revolving cylinder with a large combustion chamber on the end next to where the materials enter from the ammoniator. As the dryer turns, the slurry material proceeds down the cylinder, rolling into various size pellets and being dried by both the heat from the combustion chamber and a 75 h.p. fan.

Once the dried material reaches the end of the dryer, it is conveyed into a 7' x 47' cooler. The cooler is basically the same type cylinder as the dryer except it has only a 75 h.p. cooling fan to cool the material. The various sized pellets contain all the same plant foods which were placed in the ammoniator (no matter how large or small).

When the product comes out of the cooler, it passes over a #6 mesh screen which screens off the oversize pellets. These pellets go to a hammer mill to be crushed and returned to the ammoniator. The fine product is screened through a #10 mesh screen into a fines hopper and returned to the ammoniator. Both the oversize and fine materials go back through the dryer and cooler and complete the process of manufacturing this batch of materials into a 10-10-10 ammoniated product. The pellets that do not go through the #10 mesh screen are the finished product and conveyed to a holding bin to be either sold as bagged or bulk 10-10-10.

The final available nutrients in the ammoniated 10-10-10 are:

Total nitrogen	10.00
Available Phos. Acid	10.00
Soluble potash	10.00
Calcium	4.00
Sulfur	2.00
Magnesium	.60

The total amount of materials used in making the batch of 10-10-10 will exceed 2000 pounds; however, you have to take into consideration that during the heating and cooling process there is an evaporation loss of

332 pounds of materials along with the loss of superphosphate to absorb the free ammonia during ammoniation.

Only 18 tons of an ammoniated product can be manufactured per hour, and it takes 1-1/2 to 2 hours to clear the system after any fertilizer grade is made. Since all the plant nutrients are in the same pellet, there is a greater likelihood of more even distribution when applying an ammoniated product. When you purchase a bag of 10-10-10 with six or more plant foods guaranteed on the bag, in most instances the product will be ammoniated.

SOIL PHYSICAL PROPERTIES
for
GOLF GREENS AND ATHLETIC FIELDS

W. B. Gilbert, Raleigh Physical Soil Testing Lab, Inc.

It is possible to maintain a high quality turf on most soil textures ranging in extremes from sands to clays. The difficulty in maintenance is much greater and the proneness to turfgrass loss from environmental stresses is higher on certain soil types. Fertilization, irrigation, cultivation, and disease control practices must be varied depending on the particular soil texture (1).

Under normal conditions, aggregation and soil permeability are improved where grasses are grown. Traffic on turfgrass areas act against the natural beneficial effects of grass. On intensely used turfgrass areas soil structure may be degraded rather than improved, and compacted conditions may result. In compacted soils the particles are packed together, with the pore size distribution altered, and fewer large pores exist. The air and water relationships may vary drastically depending on the severity of compaction. Some of the conditions which are associated with compaction are hard soil, crusted soil, dry spots, standing water, shallow root systems, and plant indicators such as knotweed and clover. Various soil properties are changed when soils are compacted. The changes in physical properties are most apparent, but chemical and biological properties will be influenced by changes in the soil physical condition. When soils are compacted, bulk density, heat conductivity, mechanical impedance to roots, and usually moisture retention increase, while aeration porosity, infiltration, percolation, and oxygen diffusion decrease (2).

Soils are modified to improve plant-soil relationships, to alter the conditions of the playing surface, and to minimize soil management problems. The effectiveness of a physical soil amendment depends on the properties of the amendment, the amount added, the soil to which it is added, and the uniformity of mixing. Soil modification involves the incorporation of texture and/or structural improving materials, which may or may not involve the existing soil, for the purpose of improving the physical and chemical conditions of the turfgrass root zone. Soil modification is most commonly practiced on soils having a high clay or sand content or subjected to intense traffic. Coarse textured materials are incorporated to improve soil aeration, infiltration, percolation, and reduce compaction tendency. In contrast, finer textured materials are used to enhance water and nutrient retention.

Characteristics desired in a modified turfgrass root zone include minimum compaction tendency; good soil water infiltration and percolation; adequate aeration for deep rooting; freedom from toxic chemicals; an active micro-organism population; a certain degree of resiliency; high cation exchange capacity; and adequate water retention. There are few soils that meet these criteria. The primary objective is to minimize soil compaction by the use of coarse textured materials on turf subjected to intense traffic. Nutrient and water retention are sacrificed to achieve a minimal compaction tendency and adequate soil aeration, infiltration, and percolation.

(1) Beard, J.B. Tufrgrass Science and Culture
(2) Waddington, D.V. Turfgrass Science

SPECIFICATIONS FOR PUTTING GREEN TOPSOIL MIX

HYDRAULIC CONDUCTIVITY

Infiltration and Percolation Capacity. Bermuda 5 to 10 inches/hour. Bent 12 to 18 inches/hour.

POROSITY

35 to 55% total pore space. Capillary porosity 20 to 35%.

BULK DENSITY

Ideal 1.25 to 1.55 g/cm^3. Minimum 1.20 - Maximum 1.60.

WATER RETENTION CAPACITY

10 to 20% at 40 cm tension.

PARTICLE SIZE

The topsoil mixture ideally should contain no particle larger than 2 mm in diameter. However, 3% particles larger than 2 mm is permissible if most of these are smaller than 3 mm. The total soil mixture should not contain more than 10% larger than 1 mm and no more than 25% particles smaller than 0.25 mm (medium sand). In addition, the mixture should contain less than 5% silt and 3% clay.

PARTICLE SIZE CLASSIFICATION TABLE

Textural Name	Sieve Opening Millimeters	Top Soil Mix Limits	
Gravel	6.35	0	
Fine gravel	2.00	3% maximum. 0 over 3 mm	
Very coarse sand	1.00	10% maximum	
Coarse sand	0.50	45% maximum	
Medium sand	0.25	35% minimum.	75% ideal
Fine sand	0.10	15% maximum	25% maximum
Very fine sand	0.05	5% maximum	
Silt	0.002	5% maximum	
Clay	< 0.002	3% maximum	

Bunker sand: Ideal range 1.00 mm to 0.25 mm. Sand in this range will not remain on top of the grass, but will seep into the soil. Particles larger than 1 mm tend to remain on the putting surface and interfere with mowing operations and putting. Sand for bunkers should be light in color. and round rather than angular, if available.

PARTICLE SIZE ANALYSIS

A particle size analysis of a soil gives the amounts of particles within certain size limits. The term separate is used to designate soil particles falling within certain size limits, and the relative proportions of the various soil separates the soil texture. Textural classes are used to describe soil texture. Subclasses are also used to further describe sands, loamu sands, and sandy loams. The textural triangle indicates the limits of the various soil classes, and can b e used to determine the class when the particle size distribution is known.

Under field conditions, a trained person can estimate textural class by the "feel" method. Conditions such as grittines, smoothness, and stickiness are determined by feeling the soil between the thumb and fingers. Sandy soils are characterized by grittiness, and clays are sticky and form ribbons when pressed between the thumb and forefinger. Silt gives a smooth, velvety feel and will not form a ribbon.

Laboratory determinations of particle size distribution are usually based on sieving and sedimentation methods. Complete dispersion of soil particles must be obtained and then maintained during the analysis. Such dispersion is usually brought about by a combination of physical and chemical treatments. Particles larger than silt are divided into separates by sieving. Silt and clay separates are determined by sedimentation methods bases on Stokes' Law, which states that the settling rate of a particle in a viscous fluid varies with the diameter of the particle. The velocity of a falling particle can be calculated using Stokes' equation:

$$V = \frac{2(d' - d)gr^2}{9n}$$

where V = velocity of falling particle (cm/sec)
d' = density of particle (g/cc)
d = density of medium (g/cc)
g = acceleration of gravity (cm/sec^2)
r = radius of particle (cm)
n = absolute viscosity of medium ($dyne\ sec/cm^2$)

At 25°C the settling rate in water of a particle with the diameter of 0.05 mm (upper limit of silt) is 0.25 cm/sec, and with a diameter of 0.002 mm (upper limit of clay) the rate is only 0.004 cm/sec. (This calculates out to all the sand will be settled in a 1000 ml cylinder beaker 7.25 inches in height in 73.66 sec.)

Particle size analyses based on Stokes' equation are usually made by the hydrometer method. A hydrometer is used to measure suspension density at various times, thus reflecting the amount of particles which remain in suspension after a certain settling time.

HYDRAULIC CONDUCTIVITY, POROSITY, BULK DENSITY, WATER RETENTION

Hydraulic conductivity is a combination of infiltration and percolation capacity. This is measured by bringing the sample to a moisture content at 40 cm tension on a tension table from 12 to 48 hours, depending on the water retention capacity of the sample. With more fine particles in the sample, including silt and clay, the longer it takes to reach equilibrium. The sample is then compacted according to its use. A golf green sample is compacted with 45 foot-pounds pressure. The sample is then saturated and placed on the percolation apparatus with 25 mm hydraulic head. The percolate is measured after the flow is stabilized, and converted to inches/hr.

Soil porosity is the percentage of the total soil volume which is not occupied by solid particles. In dry soils the pores are filled with air, whereas in moist soils they contain both air and water. The amount of smaller pores, called capillary pores, will largely determine the water content, and the larger or non-capillary pores will determine the air content.

The average soil has a porosity of about 50%. Sands are usually less, and clays and organic soils are usually higher. The distribution of pore size is more important than the total porosity. The ideal situation for most crops, including turfgrasses, is to have the total pore space equally divided between capillary and non-capillary pores. If capillary pores are predominant, the moisture holding capacity of the soil will be high, but water and air movement may be inhibited due to the lack of adequate non-capillary pores. The reverse situation may produce excessive drainage and aeration at the expense of adequate moisture holding capacity.

Soil bulk density is the mass per unit bulk volume of soil that has been dried to a constant weight at 105°C. Particle density is the average density of the soil particles not including fluid space. Both of these terms are usually expressed in g/cc. If both bulk density and particle density are known, the total porosity can be calculated using these values.

Water retention of the sample has value in determining the irrigation schedule of the soil. By determining the rooting depth of the turf, and knowing the evapo-transpiration rate of the period, the amount of water available to the turf may be calculated.

$$\text{Bulk density} = \frac{\text{Weight of dry soil (g)}}{\text{Volume of dry soil (cc)}} \qquad \text{Particle density} = \frac{\text{Weight of dry soil (g)}}{\text{Vol water displaced (}$$

$$\% \text{ Porosity} = 100 - \frac{\text{Bulk Density}}{\text{Particle Density}} \times 100$$

$$\% \text{ Aeration Porosity} = \frac{\text{Saturated weight of soil (g) - 40 cm tension weight (g)}}{\text{Volume of soil (cc)}} \times 100$$

$$\text{Total Porosity} = \frac{\text{Saturated wt. (g) - oven dry wt. (g)}}{\text{Volume of soil (cc)}} \times 100$$

$$\% \text{ Water by weight} = \frac{\text{Sample weight (g) - oven dry weight (g)}}{\text{Oven dry weight (g)}} \times 100$$

$$\% \text{ Water vy volume} = \frac{\text{Sample weight (g) - oven dry weight (g)}}{\text{Volume of soil (cc)}} \times 100$$

QUALITATIVE COMPARISON OF SOIL AMENDMENTS

SOIL AMENDMENT	N DRAFT ON SOIL	CONTRIBUTE N TO SOIL	ACIDITY	CATION EXCHANGE CAPACITY
Peat Humus	None	Small	Acid	Good
Reed Sedge Peat	None	Small	Acid	Good
Moss Peat	V Small	None	Acid	Fair
Fir Bark w/N	None	Large	Acid	Good
Ground Fir Bark	Small	None	Acid	Fair
Lignified Wood Waste	None	Large	Acid	Poor-Fair
Sawdust	Large	None	Acid	Fair
Calcined Clay	None	None	Neutral	Poor
Perlite	None	None	Neutral	Poor
Pumice	None	None	Neutral	Poor
Vermiculite	None	None	Neutral	Poor
Sand	None	None	Neutral	None

SOIL AMENDMENT	COST	H_2O HOLDING CAPACITY	ROOT GROWTH PROMOTION	DURABILITY YEARS
Peat Humus	M.High	Good	Good	5+
Reed Sedge Peat	M.High	Good	Good	4-5
Moss Peat	M.High	Good	Good	1-3
Fir Bark w/N	Medium	Good	Good	5-7
Ground Fir Bark	Medium	Fair	Good	5
Lignified Wood Waste	Medium	Good	Good	8+
Sawdust	Low	Fair	Good	1+
Calcined Clay	V.High	Fair	Good	10+
Perlite	V.High	Fair	Good	10+
Pumice	Medium	Low	Good	10+
Sand	Low	Poor	Good	100+

USGA SPECIFICATIONS FOR GOLF GREEN CONSTRUCTION

Patrick M. O'Brien
Director, Southeastern Region
USGA Green Section
Athens, Georgia

Since 1945, a phenomenal growth in golf courses has occurred across the United States. The golf courses have arrived in all sizes, shapes, and descriptions. Unfortunately, most golf courses (including those with good design) have also arrived by way of poor construction methods.

It may take only a year to build a new course. But if the work is not properly done, it may take the next 8 to 10 years to untangle the mistakes and put the course in manageable order. Often initial errors can never by corrected.

Why is it today that the here and now of construction invariably capture the attention of the golf course developers, while the most important economic consideration of all, the putting green, and the untold years of maintenance that lie ahead, is hardly given a second thought? Building the best greens possible is a wise decision for any new golf course.

In 1960, after years of research, the USGA Green Section published it's "Specification for a Method of Putting Green Construction" in the September 1960 USGA Journal. These specifications were developed by extensive research, which began in 1953. Dr. Marvin Ferguson was the father of this method.

Since 1960, many greens have been built and are very functional even today, over 25 years later. However, the USGA Green Section continues to look for improvements in the method, such as with the sand layer and infiltration rates. Some questions have been answered and refinements made including:

1. Higher allowable infiltration rates.

2. The use of finer textured sands in the 1/4 to 1.0 millimeter range.

3. Including the collar area as part of the specifications too.

4. Research has shown that the sand layer is essential.
   Today, 28 years later, the USGA Green Section Putting Green Specifications remain the best proven researched method. Unfortunately, many individuals still try to gamble and ignore the research and method. Many "modified" USGA Greens are sold to clubs. The selling point is reduced costs. The USGA has contended any method that insures a green will be built right is not expensive. Only greens built poorly are expensive. I have seen problems many times with the gambles not paying off.

I would like to discuss some of the important steps in a putting green rebuilding project. Each step is quite important for the best finished product.

1. The first step is to select the architect. A list of architects is available from the American Society of Golf Course Architects.

2. The next step is to select the contractor. Once again, more calls and research are necessary for the best decision.

3. See your lawyer next. Draw up a legal contract to build the new greens to strict accordance to the USGA Specifications. Include such details as the inclusion of the 2-inch sand layer, off-site mixing, laboratory testing of the building materials by Agri-Systems of Texas, and fumigation prior to planting.

4. In the Southeast, all building materials are available locally usually except the organic materials for the top mixture. Rice hulls and Canadian sphagnum are some of the best organic materials, but must be shipped into the state. The transportation of the various building materials is usually about 50% of the total building cost. Get several samples from all the sand and organic companies for the laboratory.

5. Send these samples to Agri-Systems of Texas. Judith Goekel will perform the analysis. Since there are narrow limits on the physical and hydraulic tests, good representative samples are critical for correct analysis. Here is her address:

   Judith F. Goekel, General Manager
   AGRI-SYSTEMS OF TEXAS, INC.
   15511 Baldswelle
   Tomball, Tx 77375
   (713) 376-4412

6. Start the construction of the green base and install the drain tile. Please make the green big enough to handle the expected number of golfers. A 7,000 to 8,500 square foot green is not unusual today on courses with over 30,000 rounds annually. The finished subgrade is allowed only a 1-inch variance from the proposed finished grade. All important parties should agree with the contours of the subgrade, since no changes are allowed after this step with the finished grade.

7. Compact the subgrade to prevent future settling and space the drain lines not more than 10 feet.

8. Place tile lines with al least 4 inch diameter over a 1-inch bed of pea gravel in your drainage trench.

9. Attach a tile riser to the drainage system for later flushing.

10. Place clean washed 1/4 to 3/8 inch pea gravel over the tile lines. The pea gravel layer has a minimum thickness of 4 inches

over the subgrade. A bobcat tractor and men with hand rakes is a good way to spread the pea gravel.

11. Place 2 inches of coarse sand over the drainage layer next. The same equipment is helpful to distribute the sand in the green. Packing the pea gravel with a vibratory plow helps provide a more stable base for the workers. The coarse sand must have a range of 5 to 7 diameters to the pea gravel to restrict movement into the drainage.

12. In the meantime, mix your sand and organic matter for the topmixture off-site. The new soil blending machine is the best tool for this step. A company from Texas has invented this technology. Store some extra topmixture for future topdressing operations too.

13. Always send several samples from the soil mixing pile each day to Agri-Systems for analysis. Quality checks help to insure the correct hydraulic and physical properties at each green.

14. Line the edges of the collar with a plastic liner.

15. Transport the topmixture to each green. The final depth of the topmixture must be 12 inches. Grade stakes placed throughout the green help to insure this depth. I have seen correctly if too much or too little topmixture is installed.

16. Make sure no low pockets are seen in the finished grade. A transit is a helpful tool for this step.

17. Place a tarp over the green to cover until planting. The tarp will keep heavy rains from altering the topmixture in the upper surface.

18. Sterilize the green before planing with methyl bromide. Hire a professional fumigation company to apply this dangerous gas.

19. Seed the greens with certified bentgrass seed at 2 pounds per 1000 square feet. The seeding is normally done in September or October in the Southeast. Seeding is definitely preferred over sodding, since seeding usually results in a smoother finished surface. A new green is usually opened for play after seeding the following April or May with good weather.

20. Sod all the new rough areas around the greens and bunkers.

21. Make sure your new green and rough irrigation system is in good working order.

22. Eliminate any trees and underbrush near the greens that may restrict air ventilation.

23. Water the new bentgrass seed and watch for gemination in 5 to 10 days.

I would also take pictures of each of the construction steps along the way. I would also advise the golf superintendent to develop a good working relationship with the architect and all contractors. Your local USGA agronomist is another scientist to call to help with this important project. The USGA agronomist is aware of most of the problems with green construction, and a phone call to our office (404-548-2741) before, during or after the project may help with a problem.

I hope your new greens are successful. And remember, there are no specifications written for shortcut methods.

CONSTRUCTION AND MAINTENANCE OF THE PETE DYE COURSE AT LANDFALL

Rodney Q. Harris, CGCS
Landfall Club
Wilmington, NC

Landfall is a residential gatehouse community being developed in the Wilmington area with plans for three golf courses, a tennis and swim club and other recreational facilities. The property is being developed as a joint venture between J.P. Goforth of Chapel Hill and the Westminister Company of Greensboro. The property was purchased from the family of the late Pembroke Jones and has an interesting history.

Mr. Jones was a wealthy railroad pioneer. He began purchasing the property around 1900 to build a hunting retreat to entertain his friends who were some of the wealthiest people of that time. In 1903, Mr. Jones began building roads, a large main house and several other buildings to house the people required to maintain the property and operate the farm.

Pembroke Jones made plans for a house that would have been larger than the Biltmore House, built by his friends and rivals the Vanderbilts. The Jones mansion was never built due to the death of Mr. Jones during an medical procedure in New York. The property was willed to Pembroke Jones, Jr. the son of the elder Mr. Jones. At the death of Pembroke Jones, Jr. in 1970 the property was left to the only surviving heir, Mrs. Jane Acres.

Mr. and Mrs. Acres made plans to develop a portion of the property. In 1973 and 1974 approximately six-hundred acres were divided into single family and multi-family lots and a routing plan was completed for one 18 hole golf course by Willard Byrd and Associates. Prior to construction Mr. Acres died and the project was postponed until the property was purchased by the partnership formed in 1985 by Mr. Goforth and The Westminister Company.

In the summer of 1985 Pete Dye was hired to design the golf course. Mr. Dye did the design with input from his wife Alice, his son P.B. and Bobby Weed who is currently employed as Construction Coordinator for the PGA Tour.

Construction on the course began October 15th, 1985. Final shaping was completed in early October 1986, nearly one year later.

The irrigations system was designed using the golf course routing plan originally drawn in 1974. Spike Simmons did the initial design. The finished design, however, was a collabor-

ation between Henry Johnson the installer, Spike Simmons the consultant and the Superintendent. The finished product was a wall to wall system consisting of over 1600 Rainbird and Hunter heads and a Maxi III computerized control system.

Grassing began in July of 1986. At that time only six holes were ready. Grassing on the next ten holes began in August with the final two hole being sprigged, sodded and seeded in early October only hours after the final shaping and testing of the irrigation was completed.

Three different grasses were used on the Dye course. Tifway II hybrid bermudagrass was used on tees and fairways, Penncross bentgrass was used on the greens and Centipedegrass was used in all rough areas. The fairways were sprigged at a rate between 400 and 600 bushels per acre. As the end of the growing season approached, rates were increased. The rates were also increased in the sandy areas to insure a quick coverage.

During the summer, 85 to 90 percent grow-in was accomplished on the fairways and tees which were sprigged prior to the first of September. The fairways and tees sprigged in early September were only 60 to 70 percent covered by the first frost and the fairways that were sprigged in late September and early October went through the Winter with only 30 to 50 percent cover. Grassing was completed between the middle of April and the end of May of the following year (1987).

The perimeter of the fairways were sodded with a strip of centipede next to a strip of bermuda. This was done to give a more distinct line and to establish fairway contours. All bunker banks and slopes around greens and tees were sodded with centipede. As Fall approached more sod was used to prevent erosion from heavy rainfall which is typical along the coast in late Summer, Fall and Winter. The gentle slopes were hydro-seeded with centipede at a rate of 12 to 14 pounds per acre.

The three grasses used require different types of management. The variation in management has presented a problem in many areas, but most notably in the area of fertilization. Nitrogen requirements for Centipede are much less than that of Bermuda. Centipede requires only one-half to one and one-half pounds of nitrogen per growing season, while bermuda requirements are three to five times higher. With the centipede and bermuda being grown side by side, it became necessary to use a drop spreader to prevent over fertilizing the rough areas. Many areas are required to be fertilized by hand.

It is also evident that Centipede may not be as low maintenance as once imagined, especially in golf course situations were the owners or golfers expect a well manicured appearance. Problems with disease, specifically brown patch, was experienced in many areas on the centipede. Through conversations with other Superintendents and research personnel it had been noted that

even though nitrogen requirements are low for centipede the other nutrient requirements are about the same or higher than for bermuda or bentgrass.

Another problem is the encroachment of the centipede into the other grasses. We have used a bermuda rough cut at a height of one inch to act a buffer along the fairways. This has worked very well to prevent centipede encroachment into the fairway areas. Around tees where the centipede boarders the close cut bermuda there has been more encroachment of the centipede. However, the biggest problem seems to be along the bentgrass collars where the centipede creeps towards the putting surface, usually underneath the three-eighths inch bentgrass collars.

A few problems were experienced on the bentgrass during the first year. Cool-season brown patch began in January and continued through May and into early June. During the summer months there was a recurring problem with Southern Blight on two greens. Also during the summer there was a problem on most greens with a disease that resembled Fusarium or Ophiobolus patch. This disease could not be identified in the field or in the lab. In spite of the disease problems the bentgrass rooting depth was never less than three inches. This Fall the depth again approached ten inches.

The Dye course opened in mid-November for a property owner preview. The course is currently open to property owners and their guest. The grand opening is tentatively scheduled for late Spring or early Summer.

The second golf course, that is presently in the clearing and design phase, is being designed by Jack Nicklaus. The construction is expected to begin in May and continue through May, 1989. Grassing will begin in the summer of 1989. The course is expected to be open by June of 1990.

A long-range concern for Landfall is the effect the development will have on the environment. The Dye course should not have any significant effect. The Nicklaus course, however, will be built closer to saltwater marshes and wetlands and could present more of a problem. Holding ponds have been or will be incorporated into the design to capture storm water runoff and to prevent contamination of the sensitive areas surrounding the course. The holding ponds will be tested periodically to monitor levels of pesticides, nitrates or other unnaturally occurring substances. There is also a concern from area residents regarding groundwater contamination from pesticides used on golf courses. Information from a study funded in part by the EPA and conducted in a very sensitive groundwater area in New England provides little evidence that golf courses are detrimental to the environment. In fact the study shows that there is very little effect on the groundwater. Nevertheless, the staff at Landfall will carefully monitor pesticide programs and promote the use of

chemicals that are known to be safe.

The growth of Landfall is expected to continue for the next several years. The Dye course will officially open in the Spring. The Cliff Drysdale Tennis Center will open during the latter part of 1988 and the Nicklaus course has a projected opening date of June 1990.

BLACK LAYER AND PYTHIUM ROOT ROT OF BENTGRASS UPDATE

Leon T. Lucas
Department of Plant Pathology
North Carolina State University
Raleigh, NC 27695

Bentgrass thinning, poor growth, and even death following extended periods of hot weather has been given the popular name of black layer. The tops of the plants look normal in early stages of the disease, but the roots are weak or have died. The plants turn yellow in patches and then die slowly from what looks like dry wilt even with good soil moisture. All the grass on a green may die if the soil remains wet and hot for long periods. It has been difficult to control the disease with fungicides.

Pythium species are usually isolated from the roots and crowns of affected plants. The root-rot-type fungi have been identified as Pythium graminicola which are different from the ones that cause Pythium blight. The fungi have been found in 90-100% of the bentgrass plants sampled during all times of the year. These fungi apparently do not cause much disease unless the roots are weakened by environmental stresses such as excessive soil moisture or dry wilt. In laboratory tests, these fungi are not sensitive to Subdue, and are not very sensitive to Banol, Aliette, and Terraneb SP. The fungi are sensitive to Koban in laboratory tests and is the basis for suggesting the use of Koban to treat black layer or Pythium root rot problems.

Too much water and the lack of oxygen in the soil can occur in greens constructed with sand or in poorly drained soil. High sand content greens are often too wet, although water drains through rapidly. Nutrients are leached rapidly from the sand because of low cation exchange capacities resulting in low nutrient levels. Low levels of potassium, phosphorus, and micronutrients have been found in many of the high sand content greens with problems. Nutrient levels are usually very low in the top one to two inches of the sand during the summer unless nutrients are applied regularly. The other extreme of high soluble salts at the soil surface from too much fertilizer has been associated with the problem in some cases. Salts may be concentrated around the crowns of the plants as water evaoprates from the soil and damaging levels have been detected on greens that were allowed to become too dry.

The first indication that the black layer or Pythium root rot is developing is a bad odor in the soil. This odor is from anaerobic decomposition of organic matter and the formation of sulfur-containing compounds in the soil by microorganisms that can grow at low oxygen levels. Bentgrass roots cannot grow under the anaerobic conditions and will die if the condition exists for a certain time.

The black layer that has been observed in high sand content greens is reported to be composed of sulfur compounds and algae. This

layer forms 2 to 3 inches deep in greens that remain too wet and can be seen due to the light color of the sand. The bad odor is associated with the black layer condition. Some algae and bacteria can grow in the anaerobic conditions and the algae may fill the pores in the soil mixtures and reduce drainage.

Another factor associated with the problem on older greens is a hardpan about 3 inches deep in the soil. This layer is apparently caused by aerifyer tines penetrating to this depth and compacting the soil at the tips. The layer prevents the movement of water deeper into the soil resulting in wetter than normal soil at the surface. Roots will not grow through this layer easily which results in a shallow root system.

Poor air movement is associated with greens on which the problem first develops. The wind increases the evaporation of water which dries and cools the bentgrass. Greens in low areas that are surrounded by trees remain wetter and hotter for longer periods than nearby greens in open areas. Air movement around greens can be improved by removing or pruning nearby undergrowth of trees.

Since the primary cause of the problem is too much water in the soil, management practices that provide good soil aeration will be the best solution. Irrigation practices should include hand watering of high dry areas on greens to avoid drought stress and too much water in lower areas. Increased aeration can be provided by using proper soil mixes during construction and top dressing. Summer aerification with small tines and leaving the holes open before the grass begins to decline, or when the bad odor is detected, has been the best treatment to prevent the problem. The new deep aerifyers have been very effective for breaking the hardpan and improving drainage. The fungicides, Koban and Fore, have helped control the disease in some cases. Koban seems to work best when applied in about 5 gallons of water per 1000 ft^2. It should be applied in early morning or late afternoon to avoid burn. The fungicide Fore helps control algae and brown patch which are often associated with the problem.

Fertilization with small amounts of nitrogen, potassium, phosphorus and micronutrients each month will help to maintain the proper level of nutrients in the upper two inches of the soil where most of the roots will be growing during the summer. The amount of fertilizer added should be based on soil test results to avoid a problem with high soluble salts. Soil samples taken from the top 2 inches of greens in the summer are best for soil tests to indicate the need for these nutrients.

The best solution to the problem on many old greens will be to rebuild to proper specifications, install a good irrigation system, and alter the surrounding environment. If greens are rebuilt, a management program that emphasizes proper aerification, irrigation, and fertilization is still needed to help prevent Pythium root rot or black layer.

INSECT CONTROL FOR GOLF COURSES

R. L. Brandenburg, Extension Entomologist
N. C. State University

Golf course superintendents face a variety of insect pests each year in their constant battle to maintain turf quality. Various caterpillars, such as sod webworms, cutworms and armyworms, occur sporadically but can be quite troublesome. They can catch the superintendent "off guard" and do considerable damage in a short time. Sometimes their eggs can be seen, laid singly, on flags and markers. When this is observed, it's usually about two weeks until the worms will begin damaging the turf.

The best approach is to use a soapy water solution (two tbs. soap per 2 gal. of water) and apply in a sprinkling can to a square yard area. This solution will cause caterpillars to become active. They will move up out of the thatch and be more readily visible.

Since the worms can occur almost any time during the summer, it can take a lot of time to go scouting with the soapy water on a weekly basis. However, preventative sprays to protect high value areas, such as greens, will only be effective if applied on a regular schedule. This practice can also be very expensive if conducted all season.

At this time, diazinon can still be used for control of a variety of insect pests on golf courses. No final decision has been made by the EPA concerning their proposed cancellation of golf course and sod farm use of diazinon. Ciba-Geigy has received a turf label for their new product Triumph 4E. However, the label is restricted to home lawn use at this time.

Two major pests have created special problems for superintendents in North Carolina. One insect, mole cricket, is restricted to coastal areas, while white grubs are a problem statewide. Mole crickets have been an increasing problem for the last 10 years. While our problems are small in comparison to the damage done in Florida, Georgia and Alabama, they are still a serious threat. They damage the turf by their tunneling and loosening of the soil, as well as their feeding on roots. Mole crickets are often noticeable following overseeding in the fall. However, control is most effective in August.

Their life cycle is simple; they have one generation per year. Adults lay their eggs in July and the young emerge and feed in August. Mole crickets continue to feed and grow until the weather turns cold. As the soil temperature cools, they dig deeper and become less active. In the spring, mole crickets resume feeding until they become adults and mate.

Mole crickets are easiest to control in August. However, they are most difficult to detect when they are small. Using the previously mentioned soapy water technique will bring mole crickets up out of the soil, but one cannot search the whole course. It appears adult mole

crickets prefer to lay eggs in areas where bare soil is exposed. By checking areas where the turf is thin, bare spots, traps and around ponds, the most likely locations for mole crickets can be detected early. This may permit early control before the crickets have had much opportunity to disperse.

Triumph 4E, Mocap 10G, Orthene 75S and Turcam 2.5G have been most effective in our recent tests. Remember that Triumph is still not registered for golf course use.

Studies in other states are investigating the use of resistant varieties and even parasites and predators introduced from the crickets' South American home. As soon as any new information is available, we will evaluate its potential in North Carolina.

A new publication on mole crickets is available through my office.

Perhaps the most damaging insect to turfgrass in North Carolina is the white grub. Each year, I receive numerous calls relating stories of poor control following the application of insecticides. There may be several reasons for this problem. Poor calibration or thick thatch is often the culprit. Occasionally, spray water with a very high pH may break down the pesticide before it has an opportunity to act. The two most common reasons are no or insufficient irrigation following treatment and improper timing.

All insecticides for white grub control must be watered in with at least 1/2 inch of water immediately after application. If severe drought conditions exist, it is advisable to irrigate some before treatment. While recent studies have shown most of the insecticide stays near the soil surface and in the thatch, the watering brings the grubs near the surface where they come in contact with the insecticide.

Insecticides for grub control must also be timed to coincide with grub activity. Young grubs feed actively from August to mid-October. Fall treatments should be applied by September 15 at the latest. Most grub insecticides require several weeks before they are effective, and it is possible that cool weather could force the grubs deeper in the soil by October 1 (especially in western N.C.). In addition, cooler soil temperatures slow the grubs' metabolism and make them less susceptible to the insecticide. Spring applications should occur in late March or early April. The grubs will begin to pupate and form adults by mid-May throughout the state.

A final reason for insecticide failure could be enhanced microbial degradation. All insecticides are broken down in the soil by microorganisms. When Oftanol is used in the same location for several years, these microorganisms can increase in numbers. When this happens, the insecticide can be broken down in a matter of days, rendering it virtually ineffective. One case of this has been documented in western North Carolina. Such an occurrence does not indicate a need to abandon Oftanol as a grub insecticide but should encourage us to use insecticides wisely. Do not treat unless there are sufficient grubs to

justify the application, and be sure to treat at the proper time. While there is only one documented case in North Carolina and it has been associated with one compound, superintendents should not think it can't happen anywhere or with any compound.

A new publication on white grub control, AG-366, "White Grub Control in Turf," is available through the Extension publication office at NCSU.

A new video demonstrating techniques for detecting insect problems will be available in the spring. This 20-minute tape will be available for loan through my office.

AERIFICATION OF GOLF GREENS

J. M. DiPaola, W. M. Lewis and J. H. Monroe

North Carolina State University

Aerification has many advantages as a cultural procedure designed to improve the performance of golf greens. The advantages include improved soil wetting and relief from localized dry spots; increased O_2 and CO_2 exchange between the soil and atmosphere; accelerated soil drying, particularly of poorly drained areas; increased water infiltration and penetration of lime and fertilizers; improved mixing of soil layers; enhanced surface resiliency; reduced thatch development; and modification of soil temperature. The chief disadvantages include surface disruption; greater desiccation and increased weed and insect activity.

The timing of core aerification is critical if turf performance is to be maximized. Being a disruptive process, coring does result in turf injury and leave openings for ready encroachment by weedy plants. Thus, it is important that the turf have a good recuperative potential and that the environmental conditions are suitable for rapid turf regrowth before coring is attempted. The abrasion of leaves during the dragging of soil cores or topdressing can further aggravate the drying of the green's surface following coring. This could be very damaging under the hot, water stress conditions of late-spring and summer. Fertilizer applications, particularly those with salt nutrient carriers, increase turf desiccation by drawing more water from the leaves.

For many years, turfgrass agronomists have warned that coring should be done prior to preemergence herbicide application to avoid a breaking of the herbicide barrier. However, recent findings from studies at Michigan State University, the University of Georgia and North Carolina State University now contradict this long held axiom of turf management.

In Michigan, Branham and Rieke found that coring and returning the cores in an annual bluegrass turf one month after benefin (2 lb/acre), bensulide (10 lb/acre) or DCPA (10.5 lb/acre) did not reduce crabgrass control (Tables 1 and 2). In this study, the annual bluegrass was maintained at a 0.5 inch cutting height and 0.5 inch hollow tines were used for the aerification.

In Georgia, Johnson applied oxadiazon (2 to 4 lb/acre) in single and split (2 + 2 lb/acre) applications and oxadiazon (6.5 lb/acre) combined with bensulide (1.5 lb/acre) to bermudagrass greens. Coring with 0.5 inch hollow tines (2 inch spacing) at 1, 2 and 3 months after herbicide application failed to reduce goosegrass control. A similar study concerning crabgrass control and using 3/8 inch tines found no reduction in weed control after coring 1, 2 or 4 months after herbicide application (Table 3).

Table 1. Effects of cultivation at 0 WAT and preemergence herbicide on crabgrass populations in a Poa annua turf.

Herbicide	Rate	Cultivation procedure 0 WAT			
		One	Three	Vertical	Untreated
	lb/A	- - - - percent crabgrass 8/84 - - - -			
DCPA	10.5	0	2	--	0
Bensulide	10.0	2	3	7	7
Benefin	2.0	5	3	5	7
Control	-0-	46	42	27	47
		- - - - percent crabgrass 8/85 - - - -			
DCPA	10.5	0	0	2	0
Bensulide	10.0	2	0	4	3
Benefin	2.0	1	1	2	2
Control	-0-	23	19	28	28

Branham and Rieke, Agron. J. 1986.

Table 2. Effects of cultivation at 4 WAT and preemergence herbicide on crabgrass populations in a Poa annua turf.

Herbicide	Rate	Cultivation procedure 4 WAT			
		One	Three	Vertical	Untreated
	lb/A	- - - - percent crabgrass 8/84 - - - -			
DCPA	10.5	3	1	0	0
Bensulide	10.0	4	5	8	5
Benefin	2.0	2	8	4	7
Control	-0-	33	47	58	32
		- - - - percent crabgrass 8/85 - - - -			
DCPA	10.5	0	2	0	2
Bensulide	10.0	2	1	6	8
Benefin	2.0	4	6	2	3
Control	-0-	18	7	23	27

Branham and Rieke, Agron. J. 1986.

The objective of the studies at NCSU are to determine the influence of aerification on the performance of preemergence crabgrass herbicides under golf greens (bentgrass and bermudagrass) and fairway (bermudagrass) conditions. Oxadiazon, bensulide, pendimethalin, oryzalin, and bensulide + oxadiazon were applied as single and split applications beginning in 1987. As with the earlier findings for annual bluegrass in Michigan and bermudagrass in Georgia, crabgrass control was not decreased by aerification after application of a preemergence herbicide.

Table 3. Effects of cultivation after preemergence herbicide application for crabgrass control in a bermudagrass turf.

Herbicide†	Rate	Core cultivation timing				
		Before	1 MAT	2 MAT	3 MAT	4 MAT
	lb/A	- - - percent crabgrass (4 year mean - - -				
Control	-0-	34	63**	37	55**	54**
Oxadiazon	2	4	9*	9*	5	7
	4	6	3	8	4	2
Bensulide	10	7	5	5	8	7
DCPA	12.5	25	30	26	20	24
Bensulide + Oxadiazon	6 1.5	6	9	4	4	4
Benefin	3	7	5	7	5	5

† March applied. ** 0.01 and * 0.05 level of significance.
Johnson, HortSci., 1987.

References

Branham, B. E. and P. E. Rieke, 1986. Effect of turf cultivation practices on the efficacy of preemergence grass herbicides. Agron. J. 78:1089-1091.

Johnson, B. J. 1982. Oxadiazon treatments on overseeded putting green turf. Weed Sci. 30:335-338.

Johnson, B. J. 1987. Effect of core cultivation on preemergence herbicide activity on bermudagrass. Hort Sci. 22:440-441.

RESPONDING TO CUSTOMER COMPLAINTS

Kathy Copley, GROUNDS MAINTENANCE editor
P.O. Box 12901, Overland Park, KS 66212

When we look at customers with complaints, we ought to be able to see ourselves, and that makes it possible to empathize with the complainer. Once we do that, it is much more satisfying to make the effort to solve the problem.

Maybe the word CUSTOMERS throws you. You're the grounds superintendent of a hospital and you don't have customers per se. Think of all those people who pay your salary as your customers. On the golf course, they are your players and members. At a hospital, they are the patients and the medical staff. Your job is to give your site users and customers their money's worth. When they don't think they are getting it, you will hear from them. Business goes where it is invited, stays where it is well-treated, and grows where it is cultivated.

The first step in handling complaints is to handle people so they don't complain in the first place. As a businessman, you might be more committed to this process if you thought about what it costs to keep a customer happy vs. what it costs to recruit a replacement customer. Getting customers doesn't keep you in business. Keeping customers keeps you in business. The industry says it now costs about $80 to recruit a new customer, up from $30 a few years ago. Further, if you could compare complaints to dollars, it costs $20 in good PR to overcome $1 in bad PR from a dissatisfied customer. Another generally accepted figure is that it costs five to six times as much to get a new customer as it does to keep a current one through a good customer maintenance program.

The lawn service industry has an average retention rate of 80 to 85 percent, with smaller companies having a better retention rate than those with more than 20,000 customers. (In this group, more than half the companies lose more than 20 percent of their customers annually.) If you are in lawn servicing, 8 out of 10 of your customers are probably satisfied with the service you provide, 1 in 10 says it's too soon to tell, and 1 in 10 is dissatisfied.

Complaints

According to Customer Service Newsletter, 24 out of 25 dissatisfied customers don't complain to you. At least 6 of those 24 have a serious problem, however, in their relations with your company. Instead of telling you, the person with the complaint will tell an average of 11 other people. If you had 5 complaints this week, think of how many people are actually dissatisfied -- 120. How many people are they telling about your poor service or your rude employees? -- 1,320. Can you afford that? On the other hand, resolving customer complaints will win back up to 70% of the complainers. And prompt resolution will increase that to about 95% -- all of which should indicate that you shouldn't wait to handle the problem until after the customer has worn you down. If he feels that he has beaten you, you lost even though you gave him what you wanted.

What customers complain about has changed somewhat in the last ten years. In 1970 more people complained about price than complain about price today, but today more people complain about the quality of service, the potential danger of the products and failure of the manufacturer or service organization to handle complaints promptly and properly.

It would seem legitimate to ask why customers with complaints aren't bringing them to your attention. They have three basic reasons. They think that no one cares. They don't think you'll follow through with your agreement even if you hear them out. And they don't know who to complain to. There is a lawn and garden center on the West Coast that has solved that particular problem by putting a sign on its exit doors -- "Are you dissatisfied? Ask for Phoebe."
There isn't anyone on the staff named Phoebe. When someone asks for her, the staff member says, "Phoebe isn't here right now, but I'd be happy to help you with your concern." What this accomplishes is that this customer with a problem doesn't leave the business site dissatisfied. The customer has no reason to tell 11 other people that your service was inferior or your products unsuitable.

A survey has been done on why customers don't return to a particular place of business and, although you may not have a place of business per se, I think you'll see that the concept is a valid one. 68% didn't return to a particular lawn and garden center because of discourteous treatment, 14% because their complaints weren't adjusted, and -- in distant third place -- a lower price elsewhere. In this survey 82% of the people didn't return based on a reason that you as an employer have some definite control over.

One of the things you can do is log all complaints for service calls, call backs, etc. Then you can track any patterns that involve particular services you offer -- as a matter of fact weed control is the number one lawn care complaint. Those complaints could also center around your employees or perhaps your products. A company with which I'm acquainted found that complaints peaked shortly after their college student crew joined them in the spring. Primarily this was because the students weren't accustomed to dealing with the public, so the company instituted a one-day paid seminar on standards of behavior in handling customers -- before the job training rather than on-the-job training.

At no point do I want to create the impression that every customer is a good customer. In fact there are customers that you would rather not have. This story out of another industry will illustrate a customer you wouldn't want to have. A fellow bought a new Lincoln from the Lincoln-Mercury dealership in Dallas and he had some minor problems with it. When he took it into the dealership, the service manager said he couldn't get to it for four days but that these problems wouldn't get worse and they were no influence on the car or its safety. The man was really mad and the service manager couldn't do anything to calm him down. The new vehicle owner hopped in his car and sped out of the dealership as fast as he could -- running over one of the dealership employees in the process. This is a person you'd rather have buy a Cadillac.

You probably remember the three ways a conflict can turn out from your days of Psychology 101. They are win/lose, lose/lose, and win/win. In win/lose somebody is satisfied with the outcome. The customer may get what he wants and you may have given more than you wanted, or the reverse. In lose/lose nobody is happy. The only good way to end a confrontation is win/win -- when both of you have given the other enough to feel satisfied with the outcome.

When the time comes to get rid of a customer, how do you do it? Twenty-five percent of you do it in person; 43% of you are not quite so brave and you do it by phone; 9% do it by form letter; 7% by personal phone call; and the least brave of you -- 33% -- just don't renew the contract. Most of you do agree, however, that you don't terminate a customer until you've done everything reasonable to make that customer happy. That way at least you leave with a clear conscience.

Despite your best efforts at creating realistic expectations, offering good services at a good price, and training your employees in agronomic techniques, application techniques and customer handling, you hear your phone ringing and you soon find yourself ear-to-ear with a disgruntled customer. Research tells us that you have about 30 seconds in which to establish that you're interested in resolving the problem and that you know how to do so. First, you need to make it easy to complain. Do you have a customer service division or a customer service plan? What money and management resources have you allocated to the resolution of complaints that are real or imagined? Do you have a customer hotline or enough regular phone lines that customers won't be greeted by a constantly busy number? If he leaves his problem on a recorder, be certain that you get back to him the same day.

Second, listen to his grievances. The first three minutes can make or break the situation so you don't want to interrupt. You should take notes and review your notes with the customer to show him that you thoroughly understand.

Third, put yourself in his shoes. The caller is irritated and often what he wants more than anything else is sympathy. Use nurturing words like "I can understand your concern," but realize that sympathizing with the problem isn't the same as admitting responsibility.

Fourth, ask him what he wants you to do to rectify the situation. Sometimes he'll expect less than you expected you'd have to offer. At least you'll know what he expects and whether the solution you intend to propose is likely to satisfy him.

Fifth, tell him exactly what you intend to do. The caller wants commitment. Maybe you can't decide on the spot what you're going to do, so you can say, "I'm going to tell my supervisor" or "I'm going to visit the site personally." Give the customer a time limit. Forty-eight hours is common for a return call or a personal visit. Never tell the customer to call someone else. If in fact the customer needs to report the problem to someone else, have that someone call the customer.

And last, follow up on the complaint. Whether or not you call or visit, plan to follow up with a letter. Ask the customer whether the

situation was resolved to his satisfaction. At this point over-extending yourself is good customer relations. It sort of goes along with the Murphy's Law -- Some is good. More is better. Too much is just right.

What we've been talking about is called the Customer Service Loop. You ask questions. You listen to the answers. You probe for additional information. And then you resolve the problem.

Body language, etc.

We've been talking about what you do. How you do it is equally important. Here are some good ways to present yourself in what could be a confrontational situation. First, establish in the first three minutes that you intend to be helpful. Never point out the customer's errors. It will put him on his defensive and make it hard to establish rapport. Try to avoid the word "you," which puts the customer more on the defensive. If possible, use his name. Realize that at first, while he's angry with you, he might not level with you. You have to give him a chance to calm down before you get the truth. Use gentle gestures. Pointing your finger at the customer is an aggressive gesture. Folding your arms is an indication of resistance. Use good eye contact. People telling us the truth look us in the eye. Be aware that your dress and general appearance are important in establishing your credentials as an expert. We tend to get less angry at well-groomed people, and better-groomed representatives tend to be more believable. Consider the man dressed in a business suit versus the Bowry bum. This is not the time that you should run down your company. Short-term it may calm him down if you say, "You know, it's almost impossible to hire good technicians." But the long-term effect is that you destroy confidence in you and your company. And lastly, use common sense, and assume that the people you are dealing with possess a good deal of it themselves.

Not everyone is rational

I've been creating the impression that all customers are rational, reasonable and calm people, which of course they aren't. Sometimes they're verbally abusive or physically threatening. The best advice I can give you is to find a polite and speedy way to get out of a situation. On the phone, you could say something like this. "It's clear that we aren't going to be able to resolve this problem right now. Let me call you between four and five o'clock tomorrow at the number you gave me, and I'll have more information then. Possibly we'll be more able to resolve the problem. I'm going to hang up now but we'll talk again tomorrow." Click. Notice you don't slam the phone down. Similar phrasing is suitable in a face-to-face situation, although it may not be as easy to carry off. If you have your own vehicle, get in it and leave.

We would all be kidding ourselves if we believe that every complaint can be handled to the customer's satisfaction and yours. Some of those complaints are going to result in cancellations. A year or so ago when I cancelled my lawn care contract with a large national company, I received this letter. "We realize we may have made a mistake." The letter stresses that they want a second chance to prove that they are dedicated to serving their customers. It included two options I could check -- to resume my program or they should call me to talk. One side was a

self-mailer. The closing emphasized the tone -- "Looking forward to a new relationship," it said. Now, I'm just cynical enough to think of it this way -- did they have so many cancellations that they need a form letter?

I think the story I'm about to tell you is true because the person who told me wouldn't have told me otherwise. It's about a salesman who generally stayed at a particular motel that was part of a national chain. It had the right amenities at the right price and he just generally liked the particular company. On the occasion that I'm about to describe, he was most disappointed to discover his room had bugs in it. The chain had a good reputation, so he wrote to the local manager to bring the bug problem to his attention. He received a letter in reply which said such things as, "Thank you for bringing this to our attention. I assure you this is a problem of which we had been completely unaware. Our housekeeping staff prides itself on clean rooms and it will take whatever steps necessary ..." The tone of concern was tempered by the note from the manager to his secretary that, unfortunately, was still attached to the letter. The note said, "Send this guy the bug letter."

Communication in a nutshell

From my point of view, which is more as a customer than as a businessperson, the problem is frequently one of communication. Communication will be improved

*if you educate your customer about your services and your policies

*if you create realistic expectations and

*if you support your customer. When problems develop the customer has to know that he can call you, that you're going to listen to his problem, and that you will take action.

For better or worse, every contact you have with the customer is a form of communication. From whether the truck is clean and the technician is in uniform to how the switchboard puts him on hold, you're telling the customer what you think of him and what you think of yourself.

Behind a National Car Rental desk in the Portland airport there is this sign. "If you think something is more important than a customer, think again."

dk/7704K

HERBICIDES FOR HOME LAWNS

James H. Monroe
Agricultural Extension Agent, Stanly County

One objective of lawn maintenance professionals is to maintain customer satisfaction. Satisfied customers are repeat customers and repeat customers generate more profit in the lawn care industry.

If weed control is part of your lawn maintenance program, there are two areas that influence customer satisfaction. First, does your herbicide program adequately control weeds and second, does your program provide weed control without damaging turf and/or other plants in the landscape?

Identification of the weed(s) to be controlled is the starting point of any herbicide program. For example, broadleaf weeds vary in their susceptibility to postemergence herbicides or in the number of herbicide applications needed for control. Likewise preemergence grass herbicides do not control dallisgrass or nutsedge.

There are many good references that can assist turf managers in identifying common weeds. One example is the "Turfgrass Pest Management Manual" from the North Carolina Agricultural Extension Service. It is an excellent publication that contains descriptions and pictures of common turfgrass weeds as well as diseases and insects in North Carolina.

Once the weeds are identified, then the correct herbicides should be chosen. The booklet 'Pest Control Recommendations for Turfgrass Managers' contains susceptibility charts for broadleaf weeds, and control recommendations for other turf weed problems. After selecting the correct herbicide, check the booklet to see if it is safe to use in the turf area to be sprayed. Turfgrasses vary in their sensititity to herbicides.

Correct timing of herbicide application is critical for optimum performance. Preemergence herbicides for annual weedy grasses must be applied prior to weed germination. For crabgrass control this would be by March 25 in the Raleigh area. Postemergence herbicides should be applied to young, actively growing weeds. With all pesticides, calibrate equipment to insure uniform application of the correct herbicide dosage.

There are situations in which the wrong herbicide can damage the turf or produce effects that are undesirable. A common turfgrass mixture in the Piedmont section of North Carolina is fescue/bluegrass. These grasses are tolerant of most preemergence herbicides. However, if fine fescues are added to this grass mixture, several of the preemergence herbicides (specifically oxadiazon, oryzalin, and benefin + oryzalin) are

not recommended. Using these herbicides will thin stands and result in undesirable turfs.

Newly established (fall seeded) fescue or lawns overseeded with fescue are sensitive to preemergence herbicides. Research at North Carolina State has shown that oryzalin, pendimethalin, and benefin + trifluralin applied in the spring to fall seeded fescue reduces rooting during the first summers growth. Always check the herbicide label to determine restrictions on newly seeded lawns. For spring planted fescue, siduron is the only preemergence herbicide that can be used at seeding for crabgrass control.

Warm-season turfgrasses such as zoysia, bermuda, centipede and St. Augustine, spread by stolons. These stolons must root at the nodes (commonly called "tacking down") to become established turf. Many of the preemergence grass herbicides inhibit root growth. Stolons growing over soil treated with these type herbicides will not root at nodes. If your objective as a turfgrass manager is to thicken stands of warm season turf, then consider using oxadiazon (preemergence) or MSMA (post emergence-bermuda only) to control annual grasses until the lawn has filled in.

Another situation that can damage the landscape is incorrectly using broadleaf herbicides in turf. Drift from broadleaf herbicides can damage ornamental plants. Dicamba, a broadleaf herbicide in many three-way mixes should not be applied around shallow rooted trees and shrubs. This material can be absorbed by plant roots and damage or kill valuable ornamental plants.

To maintain satisfied customers, the turfgrass manager must assure the performance of his weed control programs. Always read and follow label directions of all pesticides. To avoid undesirable effects from pesticides become familiar with resource books and analyze each turf situation to determine the best weed control program. Local extension agents and state extension specialists are available to assist you with your turf management program.

TALL FESCUE PERFORMANCE AND MANAGEMENT

Art Bruneau
North Carolina State University
Raleigh, NC 27695

PERFORMANCE

Tall fescue is a moderate-to-coarse textured grass that tolerates a wide range of soil and shade conditions and exhibits good heat, drought and wear tolerance. Tall fescue has few serious pest problems but is subject to the disease "brown patch" (Rhizoctonia solani Kuhn) under warm wet conditions. Tall fescue grows rapidly in the spring and requires frequent mowing. It is a bunch type grass that does not recover well from injury, thus bare areas must be reseeded. Tall fescue's popularity arises from its ability to withstand heat and drought stress better than other cool season grasses. Its ability to retain green color in late fall and early spring when warm season grasses go dormant is another plus.

'Kentucky 31' is a tall fescue cultivar that has performed well for many years. Turfgrass plant breeders are developing improved cultivars of tall fescue that are finer in texture, more pest and shade tolerant and better able to withstand lower mowing heights compared to the standard, 'Kentucky 31' tall fescue. The usual absence of a difficult to control grassy weed, (orchardgrass, Dactylis glomerata L.), in seed lots of the turf type tall fescues is another reason for their popularity.

Cultivar trials at five locations throughout North Carolina suggest that the new cultivars are comparable and in some instances superior to 'Kentucky 31' in performance. Differences were not evident in Western North Carolina where the plots received minimal maintenance, i.e., no supplemental irrigation and infrequent mowing. However, in Raleigh where plots received supplemental irrigation and frequent mowing, a number of cultivars provided better turf than 'Kentucky 31' (Table 1). The enhanced quality was due to either finer texture and/or increased density. The top performers in Raleigh included Adventure, Apache, Arid, Falcon, Finelawn 1, Finelawn 5GL, Jaguar and Rebel.

All turf-type tall fescues, except 'Houndog', outperformed 'Kentucky 31' along the southeastern coast of North Carolina (Table 2). They included 'Clemfine', 'Falcon', 'Mohave', 'Olympic', and 'Rebel'. Mixtures of tall fescue and Kentucky bluegrass outperformed monostands of tall fescue. The surprising performance of these grasses deep in the Coastal Plain can be partly attributed to the trial location and maintenance received. Good air movement, high tree canopy, very little traffic and moderating temperature effects from the shade aided performance.

Tall fescue cultivars that have performed well in Virginia include 'Adventure', 'Apache', 'Arid', 'Bonanza', 'Falcon', 'Finelawn 1', 'Houndog', 'Jaguar', 'Mustang' and 'Olympic'.

The turf type tall fescues have performed well in the shade in Raleigh and have provided better performance than the traditional Kentucky bluegrass/fine fescue mixture. Tall fescue/Kentucky bluegrass mixtures seeded at 5 and 1 pounds per 1000 sq ft respectively have performed well in the shade in Raleigh compared to other blends and mixtures. Use of shade tolerant bluegrass cultivars such as 'America', 'Bristol', 'Columbia', 'Eclipse', 'Enmundi', 'Georgetown', 'Glade', 'Midnight' and 'Sydsport' will help enhance performance. The addition of one pound of fine fescue per 1000 sq ft may prove beneficial where drought and low fertility are a possibility.

MANAGEMENT

The new tall fescues are best seeded at 5 to 7 pounds per 1000 sq ft in the fall. Higher seeding rates can encourage seedling diseases while lower seeding rates result in coarser texture. Only certified seed should be planted and avoid seed containing annual ryegrass, perennial ryegrass and orchardgrass. Orchardgrass, a perennial grassy weed, is not found as often in seed lots of the newer cultivars as experienced with lots of 'Kentucky 31'. Site preparation, soil fertility and amendments, seed placement and post planting care are similar to planting 'Kentucky 31'. Siduron (Tupersan) can be used on newly seeded areas to prevent the emergence of annual grassy weeds. Fenoxaprop (Acclaim) is now available for postemergence control of annual grasses in tall fescue.

Tall fescue will persist under a wide range of soil conditions but a soil pH range of 6 to 7 is preferred. A total of 3 or 4 pounds of nitrogen annually is sufficient with 2/3 of the nitrogen being applied in the fall and 1/3 in the spring. Application of nitrogen fertilizer during the summer is discouraged because of the potential loss of plant due to environmental stress or pest attack such as brown patch.

The new tall fescues are best mowed at 2 1/2 to 3 inches. They are able to withstand a lower mowing height compared to 'Kentucky 31'; however, mowing below 2 1/2 inches will put added stress on the plants resulting in weed encroachment and environmental stress. Although there is no research to support that the turf type tall fescues are more heat and drought tolerant than K-31; summer performance may be enhanced by planting the newer cultivars where low heights of cut prevail. This is especially true for home lawns being maintained by the homeowner.

Mature stands of tall fescue are able to withstand long periods of drought without experiencing turf loss provided they are eased into dormancy. Deep and infrequent watering, mowing at a high height of cut and not over-applying nitrogen can help accomplish this goal. Weekly irrigation is often required where growth is desired during the summer months. Usually one inch of water per week will wet the soil to a depth of 4 to 6 inches. This will encourage deep rooting and help the turf withstand periods of heat and drought. Fall fertilization will enhance recovery if turf loss occurs.

Pest problems associated with 'Kentucky 31' are still of concern where improved tall fescue cultivars are grown. Improved tolerance to the brown patch disease has been reported; however turf loss can still be expected.

The new cultivars are more leafier and produce more shoots per given area compared to 'Kentucky 31'suggesting the potential for thatch development. This has been documented by researchers in Nebraska; However, the amount present is not sufficient to warrant physical removal in most instances

The newer cultivars, like K-31, do not have the ability to spread and thus overseeding to fill in bare spots will be required. The improved cultivars do blend well with 'Kentucky 31'and should be considered when overseeding thin areas of 'Kentucky 31'. This may help upgrade the existing turf and broaden the genetic base.

In summary, the new turf type tall fescues have a number of desirable characteristics to include finer texture, improved shade tolerance and the ability to withstand a lower mowing height. These differences are not always evident and the level of maintenance can affect their performance.

TABLE 1
NATIONAL TALL FESCUE TRIAL 1984-1986

Entry[1]	Turf Quality[2] Asheville	Raleigh
Finelawn 5GL	5.2	7.6
Rebel	5.2	7.4
Jaguar	5.1	7.4
Apache	5.0	7.6
Arid	5.0	7.6
Olympic	5.0	7.2
Ky31	4.9	6.5
Maverick	4.9	7.1
Tempo	4.9	7.1
ClemFine	4.8	7.2
Brookston	4.7	7.2
Chesapeake	4.7	6.7
Falcon	4.7	7.4
Johnstone	4.7	6.9
Adventure	4.6	7.6
Finelawn I	4.6	7.3
Houndog	4.6	7.2
Kenhy	4.6	5.8
Mustang	4.6	6.9
Barcel	4.5	6.3
Bonanza	4.5	7.1
Williamette	4.5	7.1
LSD	0.5	0.3

[1] Seeded 9/83 at 5 lbs/M.

[2] Turf quality on a 1 to 9 scale, 9 = best, 5 = minimally acceptable.

TABLE 2
TURF TYPE TALL FESCUE TRIAL (HAMPSTEAD), 1986

Entry[1]	Turf Quality[2] Hampstead
Ky31	5.0
Rebel	6.2
Bonanza	5.5
Mohave	6.1
Olympic	6.0
ClemFine	4.9
Rebel/Kenblue,Glade,Reliant 80/5/5/10 Mix	6.7
LSD	0.6

[1] Hampstead was seeded on 10/84 at 5 lbs/M.

[2] Turf quality on a 1 to 9 scale, 9 = best and 5 = minimally acceptable.

BASIC CONSIDERATIONS FOR IRRIGATION SYSTEMS

by

Ronald E. Sneed
Biological & Agricultural Engineering Department
North Carolina State University
Raleigh, North Carolina

Before anyone invests in an irrigation system, the decision should be made whether the system is needed and if it will provide a positive return above the cost of owning and operating the system. The basic purpose of an irrigation system is to provide soil moisture such that the crop being produced has adequate available soil moisture (ASM). Irrigation systems may also be used for stand establishment, for chemigation and fertigation and possibly for environmental modification.

These are some basic components of any successful irrigation system. These include an adequate water supply, a properly designed and installed irrigation system and a system that is adequately operated and maintained. Irrigation requires large quantities of water. To apply an effective inch of irrigation to one acre will require approximately 35,000 gallons. Water sources include surface water: streams, ponds, canals, ground water, and combination systems. Some uses may also purchase water from city or county water systems. Normally this water is metered and may be supplied under adequate pressure to operate the irrigation system without booster pumps. Three factors need to be considered with water supplies: quantity, quality and location. Most water in North Carolina is of fairly good quality, but some filtration may be required for sprinkler systems and in most cases, filtration will be required for drip irrigation systems. A water supply located close to the point of use will reduce initial pipe cost and will save on pumping costs.

There is a variety of types of irrigation systems and supplies of equipment. For most turf and ornamentals, permanent sprinkler systems and/or drip irrigation systems will be used. Some areas such as an athletic fields, memorial parks and large lawn areas may be irrigated with self-propelled traveler sprinkler irrigation systems and in the Tidewater region of North Carolina, it may be feasible to use sub-irrigation systems on very flat terrain, but this will be extremely limited in use.

Most permanent sprinkler systems will use rotary impact pop-up sprinklers, gear drive pop-up sprinklers or stationary pop-up sprinklers. The impact and gear drive sprinklers are normally used on large areas and the stationary sprinkler on smaller areas. Trees ornamentals, and shrubbery can be irrigated with pop-up sprinklers, sprinklers on permanents risers, micro-sprinklers or with drip irrigation systems.

With sprinkler systems spacing is normally 50 percent of sprinkler diameter and should not exceed 60 percent. Most drip systems and micro-sprinkler systems are designed to apply a certain amount of water to each plant.

Most sprinkler systems will use PVC plastic pipe. The trend in the industry is to use Class 200 PVC plastic pipe; however, some small residential system may use Class 160 PVC pipe. Normally, velocity is PVC plastic pipe should not exceed 5 feet per second (fps). Most large turf irrigation system use looped main lines and adequate values to isolate portions of the system to make repairs on the system.

Any of these systems need to be designed to meet the peak moisture demands of the crop being irrigated and apply water at a rate that does not exceed the infiltration rate of the soil. Normally, turf areas should be zoned separately from tree, shrub and ornamental areas.

As much care should be taken in system installation as in design. An improperly installed system can vegetate a good design; conversely, an excellent installation cannot improve a poor design. Once the system is installed, the system should be operated to meet crop consumptive (evapotranspiration) needs. The designer/installer needs to work with the operator to insure that operation and scheduling is understood. The designer needs to consider not only system hardware, but plants and soil types as he designs the system. By doing this he insures the system will meet the needs of each area to be irrigated. System maintenance is most important. Components will fail either from age or damage. Preventive maintenance is more cost-effective than corrective maintenance that can be very expensive.

In designing an irrigation system, the designer needs to consider a number of factors. These include:

- Plat plan (to scale, buildings, sidewalks, plantings, height plantings, utilities)
- Type of plantings (areas to be watered, areas to be separately zoned)
- Type of soil (soil type plus plant type will determine frequency of irrigation)
- Weather (rainfall, prevailing wind, temperature)
- Type and source of water supply (well-pump size and type pond-pump locations, power available, type of intake City water-meter size, service line back flow device required, water quality)
- Special conditions (codes, right-of-ways methods of installation)
- Finances
- Other consideration (customer equipment preference, need for booster pump, can new water meter be installed, controller location and type)

If proper attention is given to each of these factors, the customer will have a better system and in many cases the initial cost and operating costs may be reduced. Design is a key step in any irrigation system.

Most designers will design the irrigation system for a particular manufacturers product. This is acceptable, but if a different product is substituted, the design should be rechecked to insure that the substitute meets the design criteria. There are a number of good equipment manufacturers. There are differences in operational modes of equipment, especially for sprinklers, valves and controller. Owner preference may dictate the type of equipment purchased or recommendations by designers, installers or soles representatives may be the deciding factor. The important consideration is that the owner know the operating characteristics of the equipment and that service and parts be readily available.

The designer should consider all the factors listed above. However, the more knowledge the owner has about irrigation systems, the better he is able to understand the design and what it should be able to accomplish. The installer/equipment supplier needs to train the system operator and explain key parts of the system. The installer should furnish an as-built drawing so that the location of pipe, sprinklers, valves, etc. is known.

Irrigation system designs are normally prepared by the equipment supplier or installer, a landscape architect or a consulting engineer or designer. It is not important who designs the system. What is important is that a design be prepared that is hydraulically sound and that can meet the water requirements of the crop.

There have been some major improvements in turf irrigation system equipment in the last several years. System components have improved. Solid-set controllers and computers have improved automation. Equipment serviceability has improved. Pumping stations complete with all controls that can be set in place have reduced the time for installation. There is a wider variety of equipment available. Equipment suppliers have more technical representatives available to offer assistance. Most of the major suppliers offer design and service schools. Installers tend to specialize in a limited number of types of installation and this makes them more competent.

In spite of all these improvements, there are still inadequate installations and contractors (installers) are still going out of business. The customer needs to select a competent installer who will be in business five years from now and can still offer service. It is possible to purchase cheaper systems, but they may not meet the desired needs. A permanent irrigation system should be a long-term investment where finances are limited it may be advisable to install a portion of the system and complete the installation when money becomes available.

If a potential irrigation system owner will carefully select his designer/installer and not purchase the least expensive system available, it is possible to have an irrigation system that meets his needs for many years in the future and with a minimum of maintenance.

UPGRADING ATHLETIC FIELDS

Arthur H. Bruneau
North Carolina State University
Raleigh, NC 27695

RENOVATION OF TALL FESCUE AND KENTUCKY BLUEGRASS FIELDS

WHEN TO PLANT

Cool season grasses are best seeded from mid-August (Western Region) to mid-October (Piedmont and Coastal Plain Regions). However, this is not always possible. Renovation of football fields must often be postponed until after the season is complete so as not to disrupt play. Seeding of football fields in February (Coastal Plain and Piedmont Regions) and March (Western Region) is not uncommon. Seeding too early in the season can result in seed rot whereas seeding too late can result in seedling failure from weed competition and diseases.

When fields are used both spring and fall, very little can be done to establish new turf other than sodding. The best option in this instance is to insure that everything is being done to promote the existing turf. This involves proper mowing, watering, fertilization, coring, etc.

METHODS

Renovate only those areas that have been worn extensively. Kentucky bluegrass fields do not have to be overseeded if the bare areas are less than 4 inches in diameter. The existing bluegrass should fill in on its own provided proper mowing, watering and fertilizing practices are followed. Bare areas in tall fescue and perennial ryegrass fields must be overseeded since they are both bunch type grasses.

Good seed to soil contact is essential. Broadcasting seed onto the surface of the field without attempting to insure seed to soil contact often leads to failure. Mow the area as short as possible without scalping and remove excessive debris. Fill in sunken areas with soil similar to the existing root zone moisture. Several methods can be used to insure good seed to soil contact.

1. Slit Seeding:
Use of slit seeders (e.g., Olathe and Jacobson) are very effective in incorporating the seed and smoothing the soil surface with little disruption. These machines open a slit in the soil and place the seed at the desired depth. Less seed is required compared to other methods and seedling survival is excellent. Calibrate the machine to deliver 20 pounds per acre of Kentucky bluegrass and either 40 pounds of tall fescue or 20 pounds of perennial ryegrass and traverse the area twice in two different directions.

Pasture renovators can also be used; however, fields must be traversed 4 to 6 times due to wide spacing between discs.

2. Coring:
Traverse field 4-7 times with coring machine, using 3/4 inch tines that remove soil cores. Although less effective, the soil can be distributed/grooved with a vertical mower (power rake) or by disking lightly several times with the disc wheels running almost straight.

Broadcast tall fescue at 7 pounds per 1000 sq. ft. and/or Kentucky bluegrass at 2 pounds per 1000 sq. ft. Incorporate the seed and plugs with a dragmat.

3. Topdressing:
Broadcast tall fescue at 7 pounds per 1000 sq. ft. and/or Kentucky bluegrass at 2 pounds per 1000 sq. ft. existing root zone mix. This is only practical on small areas. This also helps to smooth the playing surface.

No matter which method is used, fertilize the area with a starter-type (high phosphorus) fertilizer such as 10 pounds of 5-20-20 per 1000 sq. ft. Apply the herbicide Tupersan (siduron) to prevent crabgrass competition if seeding is done in the spring.

RENOVATION OF BERMUDAGRASS FIELDS

DETERMINE EXTENT OF WINTERKILL DAMAGE

Exposure of underground plant parts to soil temperatures of less then 27°F can result in significant turf loss. Compacted areas and plants less than 12 months old are prone to injury. Determine the extent of injury before the growing season by removing several plugs of turf as soon as the soil allows, and place them in a greenhouse or south facing window that receives a lot of light. Healthy plants should green up in 2 to 3 weeks. Lack of green growth suggests the need to plan for renovation.

If large areas are dead, sprigging is the most reasonable method of reestablishment. If small areas are dead, plugging is the best method of reestablishment. Sodding may be the only option if time is of the essence.

WHEN TO PLANT

April and May are the preferred time to plant bermudagrass if you plan to schedule play in the fall. Plant as early as possible to insure that the field can withstand traffic. Table 1 provides the options available regarding field renovation.

METHODS

1. **Plugging:**
Using a plugging device, remove plugs of soil from bare areas on either 6 inch or 12 inch centers depending on speed of reestablishment desired. Most bermudagrass plugged on 6 inch centers will provide 90% ground cover in 1 to 2 months. Plugs on 12 inch centers will provide 90% cover in 6 to 12 weeks. Insert bermudagrass plug collected from sideline areas. Put bare area plugs back in holes where bermudagrass plugs were removed. Fertilize area with starter type (high phosphorus) fertilizer such as 10 pounds of 5-10-10 per 1000 sq. ft.

2. **Sprigging large areas (15,000 square feet or larger):**
Apply recommended amount of fertilizer and lime according to soil test. If test results are not available and field has not been limed in past 3 years apply 75 pounds of ag lime and 20 pounds of 10-10-10 to the area to be sprigged. Lightly disc or rotovate into soil surface being careful not to destroy the existing surface drainage or crown of the field. Spread sprigs on surface of disced area at the rate of 7 to 20 bushels per 1000 sq. ft. Lightly disc sprigs into the soil with disc set relatively straight to insure good sprig to soil contact. Some sprigs should be buried and some protruding. Those that remain on the surface will probably not survive. Roll the sprigged area to firm the soil and to insure sprig soil contact. Keep the area moist for 30 days or until the sprigs are rooted. Do not let them dry out! Fertilize with a complete (N-P-K) fertilizer such as 20 pounds of 5-10-10/1000 sq. ft. every 4 weeks until coverage is complete. This can be supplemented with a weekly application of 1/2 pound of nitrogen per 1000 sq. ft. (e.g., 1 1/2 pounds of 33-0-0) until establishment is complete. Begin mowing with a reel mower when the foliage reaches a 1-inch height.

3. **Sprigging smaller areas:**
Use a core aerator with 3/4 inch diameter tines to disrupt the soil surface. Make a minimum of 6 to 8 passes over the affected area, allow the plugs to dry and pulverize them with a dragmat. Cut out any germinating weeds such as knotweed or crabgrass with a hoe and scatter sprigs (7 to 10 bushels per 1000 square feet) on sprigged area to partially cover the sprigs. Make sue the soil used is similar to the existing soil to prevent layering. DO NOT TOPDRESS A NATURAL FIELD WITH SAND. Apply 15 pounds of 5-10-10 per 1000 sq. ft. over the sprigged area. Roll the sprigged area to firm the soil and to insure sprig soil contact. Keep the area moist for 30 days or until the sprigs are rooted. Do not let them dry out! Fertilize with a complete (N-P-K) fertilizer such as 20 pounds of 5-10-10 per 1000 sq. ft. every 4 weeks until coverage is complete. Weekly supplemental applications using an N-O-O fertilizer (0.5 pounds of N per 1000 sq. ft.) will enhance the filling in process. Begin mowing when the foliage reaches a 1-inch height.

WEED MANAGEMENT IN ATHLETIC FIELDS

W.M. Lewis
CROP SCIENCE DEPARTMENT
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA 27695

Weed management practices in athletic fields may be influenced by: 1) grass species, 2) intensity of use and 3) season of use. The most common warm-season grass species grown on athletic fields are common bermudagrass, Tifway bermudagrass and Vamont bermudagrass. The cool-season grass species include bluegrass, a tall fescue/bluegrass mixture and ryegrass/bluegrass mixture. Whether an athletic field is a spectator field or a multiple purpose field affects weed management as well as turf management practices. The more intense the use and the longer the use makes turf management and weed management more difficult. Therefore, if you expect to have a safe and serviceable athletic field, particularly a spectator field, play only scheduled games and do not conduct any sports practices, P.E. classes or band practice on the field. Weed management approaches in athletic fields are similar to other turf areas and involves: 1) selecting an adaptive grass for the locality, 2) mowing this selected grass at proper height and frequency, 3) fertilizing at the proper time and rate according to the turfgrass growth, 4) irrigating as needed to encourage establishment and to reduce stress periods, 5) aerifying or dethatching according to the turf and the amount of play and 6) using the appropriate preemergence or postemergence herbicides for the weed problem and turf present. Also remember if you bring in topsoil to smooth the field or raise the crown you can expect various grass and broadleaf weed problems: crabgrass, goosegrass, fall panicum, cocklebur, pigweed, ragweed, smartweed etc.: as found in cultivated fields. Suggestions for the control of specific weeds in athletic fields will be given on the basis of the season of growth and whether the turfgrass is bermudagrass or a fall fescue/bluegrass mixture.

Winter weeds which grow in athletic fields include annual bluegrass, common and mouseear chickweeds, henbit, hop clover, parsley piert, spurweed, and wild garlic. Wild garlic is a perennial weed while the others are classified as winter annual weeds. It is important to control winter annual weeds because they delay spring greenup of bermudagrass and the resumption of growth of tall fescue and bluegrass.

In bermudagrass winter annual weeds can be controlled with atrazine (AAtrex) or simazine (Princep) applied at 1 lb ai/A. These products are available as a 4 pound gallon, 80% wettable powder and a 90% water dispersable granule. Both atrazine and simazine are absorbed primarily by the roots of the germinating weeds and then translocated throughout the plant. Atrazine is also slightly absorbed through the foliage. These herbicides will control emerged annual bluegrass (Poa annua) and chickweed.

According to our test results the best control is obtained from applications applied from November 15 to December 30. Late applications, for example in February have delayed spring greenup of bermuda. If applications are made in January atrazine will give more favorable control and the rate should be increased to 1.5 lb ai/A.

In tall fescue/bluegrass mixtures control of winter annual weeds is achieved with a broadleaf herbicide. In most cases to control a number of different winter annual broadleaf weeds a combination product containing two or three broadleaf herbicides should be selected for effective control. Susceptibility of various weeds to specific broadleaf herbicides is given in the annual publication on pest control recommendations published by the North Carolina Turfgrass Council in cooperation with the Agricultural Extension Service. Some of the common products are: 2,4-D + MCPP; 2,4-D + MCPP + dicamba; 2,4-D + dichlorprop and 2,4-D + triclorpyr.

Examples of trade names for these broadleaf herbicides are:

2,4-D amine
Dacamine 4D
Dymec
Lesco A-4D

2,4-D + MCPP (mecoprop)
Chipco Turf Clean
Lescopar
2 Plus 2

2,4-D + MCPP + dicamba
Lesco Three-way
Trex-San
Trimec

2,4-D + dichlorprop
Weedone DPC

2,4-D + triclopyr
Turflon D

Apply the herbicide as a postemergence spray to the emerged weeds from December to March or before the turfgrass resumes active spring growth. By doing this the weeds will be removed from competition and the desired grasses will have a greater chance to fill in vacant spaces.

Knotweed germinates in late March to early April and is considered to be a summer annual weed. It frequently indicates a compacted soil. It may be controlled with Banvel, however the soil should be aerified or cored to reduce soil compaction.

Common summer annual grass weeds found in athletic fields include; smooth and large crabgrass and goosegrass. Dallisgrass, a perennial grass, annual sedges and yellow and purple nutsedge, which are perennials, are also frequently found in athletic fields. The annual weedy grasses are usually controlled with preemergence herbicides which should be applied by the time dogwoods bloom. Products available for preemergence crabgrass control include benefin (Balan), bensulide (Betasan, Lescosan, Pre-San), pendimethalin (Pre-M, Scotts Weed Grass Control),

oxadiazon (Ronstar), oryzalin (Surflan), benefin + triflurain (Team) and benefin + oryzalin (XL). Some of these preemergence herbicides affect the root development of the desired turfgrasses and therefore should not be used in the spring if bermudagrass is thin or badly worn, reseeding or sprigging of bermudagrass is planned or reseeding of bluegrass or tall fescue in the spring is anticipated. However, newly sprigged bermudagrass has shown tolerance to Ronstar applied for preemergence crabgrass control. Also, newly laid sod of Tifway bermudagrass and a tall fescue/bluegrass mixture have shown tolerance to over-top applications of Ronstar. According to the labels Ronstar or Betasan (Pre-San, Lescosan) may be used for preemergence crabgrass control in the spring on bluegrass or tall fescue seeded the previous fall. If spring seeding of tall fescue is planned, siduron (Tupersan) may be used for preemergence crabgrass control. This may be applied at seeding or before expected crabgrass emergence. This product will also provide fair control of goosegrass.

The crabgrasses and goosegrass may be controlled with postemergence applications of CMA, DSMA, or MSMA. There are various trade names for these compounds. These herbicides also control dallisgrass, bahiagrass, barnyardgrass, foxtail, annual sedges, nutsedges and sandbur. Bermudagrass is tolerant to these herbicides. While bluegrass and tall fescue are slightly sensitive, that is, discoloration may be evident for one or two mowings. MSMA may be used on newly sprigged bermudagrass for postemergence control of seedling crabgrass and goosegrass. The rate to use is 1 to 1.5 lb ai/A which should control three-leaf grassy weeds. However, if the grass weeds are larger a repeat application will be necessary in 7 to 10 days. When applying these postemergence herbicides for grass weed control there are several application techniques which should be considered. If the crabgrass plants are small (3 to 4 leaf stage) one application will usually control it. However, larger plants will require two applications 7 to 10 days apart. The usual rates for MSMA are 1.5 to 2 lb ai/A, while DSMA is used at 3 lb ai/A per application. Repeat applications at the indicated rate are more satisfactory than a single application at a higher rate. The herbicide should be applied when atmospheric temperatures are at least 80° F and with good soil moisture. Spray uniformly in 30 to 40 gallons of water per acre. Do not mow or water for at least 24 hours after application. Do not treat new seedings of grasses until they have been mowed at least three times. Do not apply the herbicides to any turf growing under stress conditions. It is best to apply herbicides to cool-season grasses early in the summer. Try to avoid applications to these grasses in mid-summer.

Summer annual broadleaf weeds which are commonly found in athletic fields include: carpetweed, knotweed and prostrate spurge. Examples of perennial weeds include: dandelion, white clover and plantains. These weeds may be controlled by the same broadleaf herbicides which were mentioned previously for winter broadleaf weeds. In some cases, weeds which are susceptible to

2,4-D can be controlled by adding 1 pint of 2,4-D to one of the MSMA applications when controlling crabgrass with a postemergence spray.

Certain application techniques are helpful when spraying postemergence broadleaf herbicides in turf. Herbicides should be applied to actively growing weeds. Herbicides will be more active when sprayed when daily temperatures are 60 to 80° F. There should be adequate soil moisture. Apply the herbicides before mowing to have ample leaf surface for herbicide absorption. Generally spray applications are more effective than granular applications. Avoid spray drift to susceptible desirable plants. Always check the label for sensitivity of turfgrasses and any other precautions. When applying to newly seeded turf, wait until after the third mowing. It has also been observed for more difficult to control weeds that using the minimum label rate or 1/2 rate and repeating in 10 to 20 days will provide more effective control. There are several factors which effect foliar applied herbicides. These may be briefly summarized as follows: Uniform spray coverage is important. The use of fan nozzles and 25 to 35 gallons of water per acre is suggested. As temperature increases within a range of 40 to 85° F the foliar penetration of the herbicide usually increases. Above 85° F volatility increases for Banvel and ester forms of 2,4-D. There should be a rain free period of 4 to 6 hours following the application of a herbicide. These herbicides are less effective if applied when the weeds are under stress. Generally high relative humidity increases herbicide action by increasing absorption. The structure and plant processes contribute to differences in retention, absorption and metabolism of the applied herbicide. Annual weeds are easier to control in the seedling stage, biennials in the rosette stage and perennials after root reserves are depleted in the spring or applications in the late summer.

Herbicides are now available for effective control of the nutsedges and wild garlic in turf. Imazaquin (Image) at 2 to 2.7 pt/A or 0.7 to 1 fl oz/1000 sq ft will control purple and yellow nutsedge and wild garlic in bermudagrass turf. Image should be applied for wild garlic control in dormant bermudagrass. For improved purple and yellow nutsedge control, Image may be applied with MSMA at 1.5lb active/A. Add a non-ionic surfactant at 0.25% v/v (2 pints per 100 gallons of spray mixture). Bentazon (Basagran) may be used for only yellow nutsedge control in bermudagrass, bluegrass, fescue and ryegrass. The rate is 2 to 4 pt/A or 0.75 to 1.5 fl oz /1000 sq ft. For optimum control do not mow 3 to 5 days before or after application.

Sometimes in athletic fields algae or moss appear, which may indicate a low fertility, low pH, a compacted soil, poor drainage, excessive water or watering, or any combination of these factors. There are certain cultural practices which may help in the prevention or control of algae or moss which include conducting a soil test and applying any suggested lime and or

fertilizer, avoiding excessive water and watering, aerifying (coring) compacted soils and improving the drainage. Algae and moss may also be controlled chemically. Algae is controlled by using 2 to 3 oz/1000 sq ft of copper sulfate. Moss may be controlled by using 5 oz/1000 sq ft of copper sulfate or ferrous sulfate. Before reseeding after chemical treatment apply 5 to 10 lb/1000 sq ft of limestone. Aerify and removed algae crust or dead moss.

In the baseline of baseball fields annual grass weeds may be controlled by incorporating very shallowly herbicides such as Balan, Pendimethalin, Surflan, Team or XL. For edging Roundup may be applied in a shielded sprayer using a 1 or 2% solution.

To illustrate weed management practices three situations are presented below with possible approaches.
Situation 1 - A newly sprigged Tifway bermudagrass field with crabgrass, goosegrass and carpetweed present. Goal is weed free bermudagrass with complete cover of the field. Solution: Apply MSMA at 1.5 lb ai/A, two applications 7 to 10 days apart. Add to the first application 1 pt/A of 2,4-D. Irrigate and fertilize the bermudagrass.
Situation 2 - A common bermudagrass/tall fescue mixture with Poa annua and wild garlic present. A low budget field. Goal: A common bermudagrass field. Solution: Apply Roundup when the bermudagrass is dormant for control of Poa annua and suppression of wild garlic and tall fescue. Apply the proper fertilizer to the bermudagrass during the summer.
Situation 3 - A tall fescue/bluegrass mixture, thin stand in the spring with crabgrass expected and chickweed and dandelion present. Goal: A dense, weed free stand of turf. Solution: Fertilize in fall and winter. Reseed in the spring. Apply Tupersan for preemergence crabgrass control. After the new seeding is four plus weeks old apply a 2,4-D + MCPP mixture for the broadleaf weeds.

This discussion on weed management in athletic fields may be ended by briefly summarizing spraying techniques for turf:

1. Select the proper herbicide for the weed and turfgrass.
2. Follow label precautions.
3. Calibrate the sprayer.
4. Apply uniformly.
5. Avoid skips or excessive overlaps in spraying.
6. Use precision equipment which include: boom sprayer, fan nozzles, dripless nozzles, pressure regulators, strainers, tank agitation, etc.
7. Employ a reliable spray person.
8. Wear protective clothing while spraying.

MOWING REGIMES FOR LOW MAINTENANCE TURF

Joseph M. DiPaola

North Carolina State University

Mowing of turf is necessary to maintain a uniform and aesthetically pleasing landscape surface. There are several practical benefits from the regular clipping of a turf, particularly for low maintenance areas. These include the control of many herbaceous weeds, a reduction in the presence of certain small animals (eg. snakes, mice, etc.) and a prevention of brushy weed encroachment. The cost of mechanical mowing currently ranges from 15 to 50 dollars per acre with an average cost estimated at 25 dollars per acre. In North Carolina, the 1986 cost of low maintenance turf mowing ranged from 53 to 84 % of the total turf management budget (Table 1). Labor accounts for greater than 50% of all mowing costs.

Table 1. Mow costs for selected North Carolina low maintenance turf areas in 1986.

Site	Mowing Costs		Total turf maintenance	Mowing % of budget
	Labor	Equipment		
	- - - in thousands of dollars - - -			%
Airports	1131	1102	2687	83
Cemeteries	1394	274	1983	84
Institutional	10455	4036	22057	66
Lawn Service	27492	12677	76368	53
Parks	7202	2727	16331	61
Roadsides	5234	5192	13920	75
Schools	2065	1724	5672	67

The depth of a turf's root system is greatly influenced by the cutting height of the shoots. The shorter the cutting height, the more shallow the rooting system of a turf. A deep, well developed root system is essential for a turf to survive under the low fertility and droughty conditions associated with low maintenance turf areas. For this reason, it is best to mow as high as practical within the recommended height range for a given turfgrass. The frequency of mowing decreases as the cutting height increases. The budget constraints of a typical low maintenance setting often dictate a relatively high cutting height and an infrequent mowing frequency compared with fine turf areas.

Scalping, a sudden reduction in the mowing height, shocks the grass and increases the likelihood of loss from pests (insects, diseases, etc.) and environmental stresses like drought, heat and cold. Overgrown sites should be gradually clipped back to the normal cutting height over two or more mowings. A recuperation period should also be allowed between each successive mowing. Each mowing should be timed so that less than 1/3 of the total shoot height is removed. Unfortunately, the practical considerations of budget and labor availability often result in low maintenance turf mowings that remove in excess of 50 % of the shoot height.

This shock to the turf is further aggravated when large amounts of clippings are left smothering the turf. This is particularly damaging to bunchgrass turf species like tall fescue which cannot effectively reenter a void once the clippings have filtered to the soil surface and decomposed. Low maintenance turf managers must recognized that such a cultural management system will inevitably lead to a thinning of the stand. Managers should schedule a renovation (reseeding) operation every several years to compensate for this turf loss. The cost of this renovation would likely be recovered in the mowing savings resulting from decreased weed pressure.

A field study was initiated at the NCSU Turf Field Center in spring 1986 to examine the degree of growth that could be permitted before mowing without adversely impacting turf quality, stand density or root development. Tall fescue plots were measured weekly for shoot height and clipped back to 6 inches when replicate plots exceeded 7.8, 9.0, 12 or 24 inches. This corresponds to a removal of 30, 50, 100 and 300 % of the total shoot height per mowing event, respectively.

At a base cutting height of 6 inches, tall fescue stand density was not adversely affected by two years of a mowing regime that consistently permitted shoot growth to reach up to 100 % more than that of the base height of cut (Table 2). However, stand density reductions exceeded 20 % when the turf was allowed to reach a height 300 % greater than the base cutting height before mowing. Maleic hydrazide treatment (4 lb ai/acre) in March for two consecutive years resulted in a more open stand of tall fescue in April, but the cover of treated plots was equivalent to untreated turf by the following October (Table 3).

References

Anonymous, 1986. North Carolina Turfgrass Survey. North Carolina Crop and Livestock Reporting Service Report No. 157. 76 pp.

Crider, F. J. 1955. Root growth stoppage resulting from defoliation of grass. U. S. Tech. Bul. No. 1102. pp. 1-23.

Table 2. The influence of mowing regime on tall fescue stand density.

Percent of shoot removed*	April 1987	Sept 1987	Mean 1986-87	Shoot number
	- - - - - - % stand - - - - - -			Oct 87
30	63	72	68	104
50	67	73	71	93
100	66	72	69	93
300	63	64	66	77
lsd	4	4	1	22
N	16	16	112	16

* Each replicated plot was mowed to a base cutting height of 6 inches when its weekly height.

Table 3. The influence of two annual spring applications (1986 and 1987) of a growth regulator on the stand density of Ky-31 tall fescue.

Treatment	April 1987	October 1987
	- - - % cover - - -	
Untreated	63 a	74 a
MH	66 b	76 a

Means within a column with like letters are not significantly different according to the Waller-Duncan K-ratio t-test.

WEED CONTROL IN LOW MAINTENANCE TURF ALONG HIGHWAY ROADSIDES

W.M. LEWIS
CROP SCIENCE DEPARTMENT
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA 27695

Herbicides can perform a vital role for weed management in turf along highway roadsides. Used safely and properly herbicides can be of value in reducing labor and equipment costs, conserving energy and providing a more favorable appearance along roadsides. Newer herbicides have also made it possible to selectively encourage certain grass species while discouraging others. Weeds may reduce sight distances, encourage the deterioration of pavement surfaces and pose potential fire hazards. Weeds compete with desired turfgrasses for nutrients, moisture and light, reducing the competitive ability of the turfgrass. This competition may open areas to greater erosion hazards, which in turn create unsightly roadsides.

Perhaps, the most commonly used herbicide for postemergence control of annual and perennial broadleaf weeds along roadsides is 2,4-D amine which is used at the rate of 2 to 4 pt/A. Most roadside turfgrasses are tolerant such as fescue, bluegrass, bahiagrass and bermudagrass. However, the rate should not exceed 1 pt/A on centipedegrass. Combination products containing 2,4-D plus another broadleaf herbicide are also available for broadleaf weed control along roadsides. One of these is Weedone DPC (2,4-D + dichlorprop) used at 3 to 4 pt/A. The combination products provide control of a greater number of different broadleaf weeds and perhaps increase the control of certain perennial broadleaf weeds and aid in the suppression of small woody plants. Fescues, bluegrass, bahiagrass, bermudagrass and perennial ryegrass are tolerant to Weedone DPC. Again on centipedegrass the rate should be cut in half. Turflon D (2,4-D + triclopyr) is used at 3 to 4 pt/A. It may be used in tall fescue, bluegrass and perennial ryegrass. This product will also improve control of some of the more difficult to control broadleaf weeds and suppress some small woody plants.

It is very difficult to effectively manage a turf consisting of a mixture of warm-season and cool-season grasses. It is more desirable to have a single species which can be managed properly according to fertility and mowing requirements. Herbicides are available which will release warm-season turfgrasses such as bahiagrass, bermudagrass and centipedegrass from the competition of other grasses. The herbicide weakens or controls the competing turfgrass. This program has the potential of reducing mowing to once a year or even eliminating mowing with the control of broadleaf weeds in addition to releasing the warm-season species. Oust may be used in dormant bahiagrass and bermudagrass as a warm-season release. It should be applied in late winter before bermudagrass or bahiagrass begins to greenup. Oust is both foliar absorbed and root absorbed. Also, some

residual effects can be expected on later germinating weeds and grasses as well as controlling tall fescue. It is used at the rate of 0.5 to 0.75 oz/A. For bermudagrass release the rate is increased to 1 oz/A. This will control bahiagrass and perhaps delay greenup of bermudagrass. No surfactant is added to Oust spray solutions. A spray volume of 25 to 35 gpa is sufficient.

Roundup applied alone at 12 to 16 fl oz/A may be also used for release of bahiagrass and bermudagrass. Since Roundup is absorbed by green foliage tall fescue and other competing species must be vigorously growing and the desirable vegetation be dormant for release to be successful. To the spray solution add a non-ionic surfactant at 0.5% v/v. Spray volume should be in the 10 to 25 gpa range.

There is also a label recommendation for a combination of Roundup and Oust for release of dormant bermudagrass and bahiagrass. Roundup is used at the rate of 12 to 16 fl oz + 0.25 to 0.75 oz/A of Oust. It is suggested a non-ionic surfactant at 0.5% v/v to be added to the spray solution. Again the spray volume is 10 to 25 gpa. The combination treatment may provide greater activity on the green foliage at the time of spraying plus Oust adding residual grass and broadleaf weed control. Oust should not be used in the rooting zone of desired trees and shrubs.

Roundup and Roundup/Oust combinations may also be used for control or suppression of annual grass and broadleaf weeds and certain perennials including tall fescue, bahiagrass and johnsongrass. The rates for Roundup are 1 to 3 pt/A when combined with Oust the Roundup rate is reduced to 1 to 2 pt/A plus 1 to 2 oz of Oust/A. Add surfactant to the spray solution and spray in 10 to 20 gpa.

In recent years we have conducted a considerable number of studies on the release of actively growing centipedegrass. Oust and Poast herbicides have proven to be very effective. Two applications of Oust at 0.75 oz/A/application spaced 14 days apart will control annual grass and broadleaf weeds, tall fescue and bahiagrass. Oust should not be used in the rooting zones of desired trees and shrubs. Two applications of Poast at 1.5 pt/A/application spaced 28 days apart has given excellent control of annual grass weeds, tall fescue and bahiagrass. In addition this treatment will suppress bermudagrass. Add 2 pt/A of oil concentrate to the spray solution. Many ornamental trees and shrubs are tolerant to Poast.

Broomsedge along highway roadsides can obstruct the line of sight and increase fire hazard. Studies conducted at North Carolina State University have clearly shown that broomsedge may be controlled in highway roadside tall fescue thus reducing the necessity of fall mowing. MSMA has proven to be a very effective herbicide for control of broomsedge. In addition it will provide control of annual grasses such as crabgrass and foxtail and

suppress perennial grasses such as dallisgrass and johnsongrass. We have examined several different rates and times of application and single and multiple applications. A single application of MSMA at 2 lb ai/A provided the best control. The window of application is from early August to mid-September. Treatments applied during this period control broomsedge thus eliminating the fall mowing requirement. Furthermore, control the following year has remained at 90% or above.

The following is just a summary of herbicides which may be used for woody plant control along roadsides. Most turfgrasses have tolerances to these herbicides except when used at high rates. Herbicides which may be applied for woody plant control include: Banvel, Banvel + 2,4-D, Crossbow (Garlon + 2,4-D), Garlon and Krenite. With the exception of Krenite, the best time to apply the herbicides is following full leaf development in early spring. Krenite is applied in late summer at least 2 weeks prior to any natural leaf discoloration. Multiflora rose is another pest found along highway roadsides. Herbicides which control multiflora rose to which turfgrasses exhibit tolerance include Banvel, Crossbow and Krenite. Roundup and Spike may also be used for control of multiflora rose. However turfgrasses are not tolerant to these herbicides. Roundup can be applied following full bloom of multiflora rose using a 1% solution with a nonionic surfactant at 0.5% v/v. A 1% solution of Banvel is also effective when thoroughly spraying the foliage and allowing the spray solution to run down the canes into the soil. Banvel pellets should be applied before leaf buds appear early in the spring. Spike pellets are more effective when applied early but they may be applied during the growing season. Krenite is applied as a spray in late summer before any leaf deterioration. To be effective all foliage must be sprayed.

Herbicides can be effectively used as part of the total management system of turfgrasses along highway roadsides thus improving the safety and beauty of the highway as well as reducing labor and equipment costs.

N. C. DEPARTMENT OF TRANSPORTATION WILDFLOWER PROGRAM

by

WILLIAM D. JOHNSON

The North Carolina Department of Transportation has developed and implemented a state-wide wildflower program along our roadsides. We began this program 2 seasons ago with the installation of approximately 12 acres of wildflowers on an experimental basis. We utilized a southeastern wildflower mix for this original installation. After some success with this work we then determined which species had done best and purchased individual species for last season's work and this season's work. These species were mixed with 1 or 2 and sometimes 3 types in a strip area. The long narrow strips along our roadsides that many have seen sometimes covered with plastic, as they are being fumigated with Methyl Bromide, are these wildflowers areas. The first season we seeded approximately 12 acres with the second season and this fall's installation totaling 140 acres each. Thus, we now have close to 300 acres of wildflowers seeded along our roadsides.

We felt it was important to prepare a good seed bed and fumigate with Methyl Bromide in order to get the wildflowers initially established then hoping that they would naturalize into adjacent roadsides areas. Although expensive this process has been very successful from the standpoint of initial stand. The long range establishment is still yet to be determined.

Some of the different species of wildflowers that have been successful for us are Black-Eyed Susan, Plains Coreopsis, Ox-Eye Daisy, Toad Flax, Phlox, and California Poppy. We have also identified and collected seed from several indigenous wildflower species, including one we are very excited about on a state-wide basis, Bidens Aristosa or Bur Marigold. This is a yellow daisy type flower which blooms along our roadsides during the month of September up to frost.

There are some very reliable seed suppliers of wildflower seeds that have developed across our country. Seed supplies are good and seed quality generally is excellent. Probably the best way to start usage of wildflowers is as we did with a southeastern wildflower mix.

We were also very involved this past year with the 1987 Olympic Festival and the landscaping that took place as a part of that event in our state. For this festival event we planted trees, shrubs, bulbs and annual flowers along routes going to and from competition sites.

This landscaping consisted of the planting of 1,200 crepe myrtles, 700 dwarf crepe myrtles, 2,100 junipers, 1,000 pampas grass plants, 1,000 wax myrtles, 100 Bradford pears, 28,000 canna lilies and 5,000 daylilies. The most extensive part of the planting, though, was the installation of 21 acres of annual flowers. These included Salvia, Ageratum, Vinca and Petunias along with some Marigolds.

The 21 acres of annual beds were fumigated and planted with 53,000 dozen annuals as noted. There was a very serious drought during this time period as it only rained 4.6 inches at Raleigh Durham Airport from May 1st to August 1st. Because of this we had to haul approximately 4 1/2 million gallons of water onto these planted areas to insure survival.

The miracle in all this is that we were successful, we had the areas in full bloom during the Olympic trials in July and we received a tremendous number of positive comments because of this work.

The funding for this effort was a result of a partnership between DOT, local governments, Airport Authority, Research Triangle Foundation and private companies. Their involvement shows the tremendous interest that now abounds for landscaping and the utilization of flowers.

WEED CONTROL RESEARCH IN 1987

W.M. LEWIS
CROP SCIENCE DEPARTMENT
NORTH CAROLINA STATE UNIVERSITY
RALEIGH, NORTH CAROLINA 27695

Preemergence crabgrass herbicides applied on March 24, 1987 were evaluated for their effect on rooting of tall fescue seeded the previous fall on November 6, 1986. Tall fescue root strength was measured by the force required to pull the treated fescue free from the soil. Root strength measurements and turf quality evaluations were conducted 49 and 149 days after treatment. Ronstar had the least effect on root strength and was similar to the untreated. Surflan reduced root strength the greatest, followed by Pendimethalin. Team was intermediate. Prodiamine had a slight effect at 49 days and was intermediate at 149 days. At 149 days after treatment quality ratings for Prodiamine and Ronstar were similar to the check. Team was significantly lower than the check and Pendimethalin and Surflan quality ratings were significantly lower than Team.

This season we continued our evaluations of comparing single versus split applications of preemergence herbicides for crabgrass control. Split applications were applied 8 weeks after the first application. Smooth crabgrass control ratings were taken in June and late August. Betasan at 12.5 versus 7.5 + 7.5 lb ai/A did not provide effective season long control. Ronstar at 3 versus 2 + 1 lb ai/A only gave effective control at the 3 lb ai/A rate. Pre-M at 3 lb versus 1.5 + 1.5 lb ai/A gave effective control for both application techniques as did Prodiamine at 1 lb versus 0.75 + 0.25 lb ai/A. Surflan at the split application 1.5 + 1.5 lb ai/A versus 3 lb was slightly more effective as was the split application of XL at 2 + 2 lb ai/A versus 3 lb. Single and split applications of Team gave poor control at the end of the season.

Lawn care companies have a need to apply preemergence crabgrass herbicides over a several week period. Therefore, we evaluated applications applied February 11 and 25, March 11 and 25. Split application came in late April or during May. Smooth crabgrass control was excellent for Betasan 7G, Surflan 4AS, Pre-M 60DG, XL 2G whether applied as a single or split application. Ronstar treatments were poor to good. Goosegrass control was essentially non-existent with Betasan. Goosegrass control with Surflan and Pre-M was very effective whether applied as a single application or split application. Split applications of XL showed a slight improvement in goosegrass control over single applications. Single and split applications of Ronstar ranged from poor to good.

Our research emphasized that Image (imazaquin) should not be applied to bermudagrass just prior to spring greenup or during spring greenup for it will retard greenup. Image was also

evaluated for purple nutsedge control. The best control was obtained with 0.25 lb ai/A of Image plus 2 lb/A of MSMA. However, for best control it appears that two applications may be needed during the growing season. Evaluations next summer will help to determine the need for a second application for the control of this perennial sedge.

We have continued our evaluation of AAtrex and Princep for Poa annua control in bermudagrass. Our data again this year indicates the best time for application is from mid-November to late December. When applied at this time, 1 lb ai/A of either herbicide will give very effective control of Poa annua and many other winter annual weeds found in bermudagrass. Reduced control will be obtained with applications as late as February, furthermore there is potential of reducing spring greenup from these late applications.

Turfgrass Extension Entomology Update

R. L. Brandenburg
Extension Entomologist
N. C. State University

Several changes in pesticide registrations occurred in 1987. The home lawn use has been dropped from the Mocap 10G label. Triumph 4E received a label for insect control in home lawns, and diazinon is still under review by the EPA concerning its golf course and sod farm label.

Control studies on ground pearls have yielded some success. This insect has been a frustration to lawn care personnel for many years in the coastal plain of North Carolina, and the problem appears to be spreading. Our studies will continue in 1988 to further refine the timing of insecticide applications.

Studies on white grub control have confirmed the effectiveness of Triumph. At the same time, these trials documented enhanced microbial degradation of Oftanol in western North Carolina. While this should not be viewed as justification for dropping the use of Oftanol from a white grub management program, it should encourage the wise use of this insecticide.

Additional studies on mole cricket control have found Triumph 4E and Turcam 2.5G to work as effectively as Orthene 75S. However, Triumph is not labeled at this time for use on sandy soils. Studies on mole cricket migration will continue next year.

Imported fire ants continue to move northward. They were found in several new counties this year and may eventually establish as far north as Raleigh.

A new video tape on detecting insect pests in turf is in the final stages of production and should be available for loan by early spring. All interested viewers should contact my office concerning its use.

Turf Disease Update

Leon T. Lucas
North Carolina State University
Raleigh, NC 27695

The research project on spring deadspot of bermudagrass that was funded by the United States Golf Association was completed in 1987. Dr. Bert McCarty, who accepted a position in turfgrass management at the University of Florida, was in charge of the project.

A fungus was isolated and shown to cause spring dead spot of bermudagrass. Three isolates of a dark-gray, slow-growing fungus isolated from bermudagrass cv. 'Tifway' with spring dead spot (SDS) symptoms were tested for pathogenicity on bermudagrass. One isolate produced typical SDS symptoms on bermudagrass when potted plants were inoculated in the fall and grown outside during the winter. Top and root weights of plants inoculated with isolate B were 92 and 71%, respectively, less than the control. Isolate B produced asci and ascospores in perithecia on the dead stolons and was identified as Gaeumannomyces graminis var. graminis. The same fungus was identified from perithecia and ascospores on naturally SDS-infected bermudagrass from North Carolina and Alabama in May 1987. This is the first report of G. graminis as a causal agent of SDS on bermudagrass.

Experiments to evaluate the control of spring dead spot with fungicides were conducted in Alabama, North Carolina, and Virginia. Ten treatments that included fungicides, fertilizers, and growth regulators were applied to bermudagrass fairways in the fall of 1986 where spring dead spot occurred in the spring of 1986. Preliminary results were obtained in the spring of 1987 and the tests were established again in the fall of 1987 to obtain final results in spring 1988. Applicaitons of Rubigan at 1 oz/1000 ft^2 in September, and Tersan 1991 at 6 oz 1000 ft^2 in October gave the best control of SDS in May of 1987 in North Carolina. Rubigan gave better control of SDS than Tersan 1991 in Alabama.

Previous research on spring dead spot control has indicated the involvement of cold weather in disease development. Protection from cold damage by the fungicide Tersan 1991 has been observed in earlier experiments. Fungicide and fertilizer treatments were applied to Tifway bermudagrass plots in the fall of 1986. Plugs of turf from the treatments were exposed to different temperatures near or below freezing and then were placed in a greenhouse for regrowth. Preliminary data confirmed that the fungicide Tersan 1991 increased the cold hardiness of bermudagrass by a few degrees. This experiment was repeated in the fall of 1987 and we will have final results in the spring of 1988.

Decline of bentgrass was a serious problem again in the summer of 1987. Isolation results indicated 80-90% of the bentgrass plants were infected with Pythium graminicola in the spring and summer.

Management programs that insure good soil drainage and promote good root growth resulted in the best survival of bentgrass. Greenhouse experiments are being conducted to evaluate the pathogenicity of P. graminicola on bentgrass under various soil and moisture conditions.

Fungicides were evaluated for the control of Pythium root rot fungi throughout the spring and summer. Results in the table show that most of the bentgrass plants were infected with the fungus in May. The number of infected plants were significantly lower with Fore in May and with Aliette and Koban granules in July. However, visual improvement of the bentgrass from fungicide treatments was not observed in this experiment. Additional evaluations are needed to determine if Pythium root rot fungi are causing serious damage on bentgrass and are involved in summer decline.

Evaluation of fungicides for control of Pythium root rot on bentgrass.

Treatment and rate/1000 ft^2	Application date*	No. of infected plants**	
		13 May	14 Jul
Form-A-Turf 30% 6.4 oz	A,M,J,J	23.8	13.8
Form-A-Turf 30% 6.4 oz	J,J	24.0	16.3
Koban 30WP 6 oz	A,M,J,J	25.0	13.3
Koban 30WP 6 oz	J,J	24.0	16.3
Aliette 80WP 4 oz	A,M,J,J	24.5	8.0
Subdue 2E 2 oz	A,M,J,J	23.8	18.3
Fore 80WP 6 oz	A,M,J,J	19.8	10.0
Koban 1G 2.6 lb	A,M,J,J	23.3	8.25
Control		24.5	16.0
LSD (P = 0.05)		1.8	7.5

*Apr, May, Jun, Jul
**No. infected plants out of 25 on given dates.

Turf Extension Update

Arthur H. Bruneau
North Carolina State University
Raleigh, NC 27695

The aquatic and non-crop land weed position has been filled by Dr. Stratford Kay. His appointment is 50% extension and 50% teaching. Dr. Kay received his doctorate from the University of Florida in 1980 in Aquatic Weed Science and has most recently held a research position in aquatic weed management at Delta State University, MS. He has a wide range of experience including biological control (especially alligatorweed), herbicide usage and their fate in the environment, as well as their effects on water quality and non-target species. Questions concerning aquatic weed control in lakes and ponds should be addressed to Dr. Kay who can be reached at Box 7620, NCSU, Raleigh, NC 27695.

Revised and updated fertilizer recommendations based on soil test results for home lawns are now in effect. This was the result of a joint effort by the Crop Science turfgrass work group and members of the North Carolina Department of Agriculture. These changes are designed to bring the fertilizer rates more in line with plant nutrient requirements and to allow more flexibility in time of application, particularly for nitrogen. Nitrogen recommendations will be reduced from 2 to 1 pound per 1000 sq ft and a schedule provided for supplementing nitrogen at a time when application is most desirable. Separately, the nitrogen for centipedegrass will be reduced to 0.5 pounds of nitrogen per 1000 sq ft. Phosphorus and potassium rates will be reduced according to soil test levels and will be eliminated completely when the soil test index is above 50.

The TCNC again jointly sponsored a turfgrass demonstration area during the NC State Fair. This is the third consecutive year that those attending the fairs were allowed to see first-hand some of the major grasses grown in NC.

THE TURFGRASS COUNCIL OF NORTH CAROLINA, INC.

The Turfgrass Council of North Carolina is a Non-Stock Association incorporated under the laws 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 study and research in turfgrasses; (3) to disseminate information relating to turfgrasses; (4) to represent the turfgrass industry in matters of policy. The objective of the Council is to help obtain the best turf possible for lawns, recreational areas, roadsides, and cemeteries throughout the state.

ACTIVITIES

The Annual North Carolina Turfgrass Conference and the NCSU Turf Field Day are co-sponsored by the Turfgrass Council and North Carolina State University. A newsletter is published to inform the membership of council activities and turf programs in the state. Turfgrass research, extension, and scholarship programs receive financial support from the Turfgrass Council. A Turfgrass Research and Extension Fund has been established at NC State University to provide additional funds for turf research and extension programs.

MEMBERSHIP

Individuals interested in turfgrasses, representatives of turf related organizations, and sales representatives of turf products are encouraged to become members. Dues for individuals are $30 per year. Sustaining memberships at $75 are also available. Membership application forms are printed in the North Carolina Turfgrass News. Additional information can be obtained from Mr. R. L. Robertson, Executive Director of the TCNC (P.O. Box 5395, Cary, NC 27511, phone 919/467-1162).