PROCEEDINGS OF THE 23RD ANNUAL NORTH CAROLINA TURFGRASS CONFERENCE

Volume VI

January 2-4, 1985

Charlotte, N. C.

Sponsored by

Turfgrass Council of North Carolina

North Carolina State University

North Carolina Agricultural Extension Service

PREFACE

Proceedings of the 23rd Annual North Carolina Turfgrass Conference are being provided as a permanent reference to those who attended the conference. The 1985 conference was held at the Adam's Mark Hotel in Charlotte, N. C., on January 2, 3 and 4. Sessions with general turf topics and concurrent sessions for golf course, lawn care, parks and recreation, roadside and low maintenance turf, landscape maintenance, sod, and pesticide topics were scheduled. Workshops on Establishment and Maintenance of Lawns, Aquatic Weed Identification and Control, and Irrigation Repair and Maintenance were held for the first time in the afternoon of January 2. The trade show had 52 booths and approximately 800 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 and for providing a written summary for the proceedings. 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 North-South Turfgrass Association. The following committee members contributed to the success of the conference.

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Printed in June 1985

The 1986 North Carolina Turfgrass Conference will be held in Winston-Salem, N. C., on January 8, 9 and 10.

Additional copies of the proceedings are available at $5.00 each from Dr. L. T. Lucas, Department of Plant Pathology, NCSU, Box 7616, Raleigh, N. C. 27695-7616. Make checks payable to The Turfgrass Council of North Carolina.

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PAST AND FUTURE DEVELOPMENTS IN WARM SEASON TURFGRASSES

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An ideal turfgrass should be a dependable perennial capable of maintaining a green, dense, weed-free turf under frequent mowing. It should be resistant to pests (diseases, insects, nematodes, etc.) and wear; tolerant of shade, cold, drought, heat, and chemicals; and it should possess low weed potential. Few species can begin to satisfy these requirements. For the humid, southeastern U.S., the species that best qualify are bermudagrass, Cynodon spp; centipedegrass, Eremochloa ophiuroides; St. Augustinegrass, Stenotaphrum secundatum; Carpetgrass, Axonopus affinis; Zoysiagrass, Zoysia spp.; and bahiagrass, Paspalum notatum.

All of these species except the tetraploid bahiagrasses that are apomictic, reproduce sexually and produce variable offspring. Out of this natural variation came the first named varieties of the above species. Usually they were found on golf courses or lawns, were recognized as superior, and were removed, tested, and released with a name. Examples were Bayshore, Everglades, Ormond, and Texturf bermudagrasses; Oklawn centipedegrass; and Bitter blue, Floratine, and Roselawn St. Augustinegrasses. This method of developing superior turf grasses is still being used as evidenced by the release of the more winter hardy Vamont bermudagrass from Virginia Polytechnic Institute and State University and Raleigh St. Augustinegrass from the North Carolina Agricultural Research Service.

The first conventional breeding of warm season turfgrasses was begun in 1942 when we crossed a very dense sodded dwarf, C. dactylon with disease resistant selections from our pasture breeding program. Twelve of the best of these, and a number of bermudagrasses selected from superior golf greens across the South, were tested in small plots at Tifton beginning in 1946. By 1952, we had enough data to prove that one of our 12 hybrids was superior to all others in the test and it was released to the public as Tiflawn (Tifton 57).

The next product of our turf breeding program was Tiffine (Tifton 127), a cross between Tiflawn and C. transvaalensis. This sterile triploid had a softer, finer texture and was better suited for golf greens than Tiflawn. It was soon replaced, however, by Tifgreen (Tifton 328), an F_1 triploid hybrid between C. transvaalensis and a superior C. dactylon from a golf green at the Charlotte Country Club in North Carolina.

Tifgreen, officially released in 1956, made a better putting surface than other varieties and has been extensively planted on golf greens. It has also been used to a lesser degree on fairways, tees, and lawns.

Our fourth improved turf variety (released in 1960) was Tifway (Tifton 419), a dark green sterile triploid (C. transvaalensis x C. dactylon) hybrid with greater frost tolerance. Its stiffer leaves and greater pest resistance made it particularly well suited for golf fairways and tees, lawns, and athletic fields with moderate wear.

In 1965, we released Tifdwarf, a vegetative mutant of Tifgreen. Tifdwarf has finer stems, shorter internodes and smaller, softer, darker green leaves than Tifgreen. It makes a denser turf and, when mowed at 5 mm and properly managed, makes a putting surface comparable with the best bentgrasses. Although planted on lawns, it is best suited for golf greens.

All interspecific C. dactylon x C. transvaalensis hybrids are sterile and shed no pollen. This makes them attractive lawn grasses for people who are allergic to bermudagrass pollen. Such sterility facilitates their control, yet it imposes no serious handicap on their use, because they can be easily propagated by planting sprigs. The sterility of these hybrids does, however, prevent their improvement by the common plant breeding methods of hybridization and selection.

When attempts to produce interspecific hybrids better than the Tif bermudas failed, we decided to try mutation breeding. Dormant sprigs of Tifdwarf, Tifgreen, and Tifway were exposed to gamma radiation in the winter of 1970-71 by Dr. Jerrel Powell and the plants that developed from them were space planted in the field. From these plants he isolated 158 mutants that were different than the normal hybrids. Repeated tests of these mutants enabled us to release Tifway II in 1981 and Tifgreen II in 1983. Tifway II that looks like Tifway is more resistant to nematodes, is more frost tolerant, more weed resistant and often greens up earlier in the spring. Compared under minimal management with Tifgreen, Tifgreen II is more resistant to weeds, mole crickets, and nematodes, exhibits better spring recovery, is lighter green in color, and develops much less purple color at low termperatures.

Perhaps the greatest future need for all of the warm season grasses is to increase their winterhardiness. Between the regions where the cool season grasses and the warm season grasses are dependable lies the 'transition zone' where cool season grasses fail in hot humid summers and warm season grasses die during severe winters. Cultivars with greater winter hardiness would be a great boon to all who use warm season grasses in the transition zone. This need is particularly great on golf greens where frequent close mowing greatly increases the susceptability of a cultivar to winter killing.

In the summer of 1966, I found in Berlin, Germany, a common bermudagrass that has been able to survive the winters at Lake City, Michigan. By crossing this Berlin bermudagrass with Coastal, we were able to develop the winter hardy pasture bermuda, Tifton 44. Two selections from the Berlin bermudagrass survived perfectly when others died on the Pine Valley Golf Course, New Jersey in the severe 1980 winter. The need is for a C. transvaalensis plant as winter hardy as these two Berlin bermuda selections.

We believe C. transvaalensis originated in the Transvall of South Africa. Where, no one seems to know. Among the bermudagrass introductions from South Africa, we have been able to find only 10 that are C. transvaalensis. Many so labeled proved to be sterile triploid hybrids when examined cytologically. Dr. Kenyon Payne in Michigan and Dr. Ralph Engel in New Jersey are evaluating these 10 introductions for winterhardiness. If we can find one as winter hardy as our best Berlin selection, we can surely produce triploid hybrids between them that will be

substantially more winterhardy than the Tif bermudas.

Mutation breeding may help to solve the winterhardiness problem. Out of irradiated sprigs of Coastcross-1, a sterile pasture bermudagrass hybrid, grown at the Georgia Mountain Experiment Station, Blairsville, Ga., we found one plant that survived a winter there and possessed improved hardiness when further tested. The improvement was not great enough for turf needs and our efforts to repeat this success failed because winters there were either too mild or too cold.

Dr. Wayne Hanna is using a different approach at Tifton that offers promise. Midiron, a sterile bermudagrass triploid developed by Ray Keen at Kansas State University, is reported to be more winterhardy than any of the Tif bermudas. However, Midiron makes an open turf of poorer quality than the Tif bermudas. Among 70 mutants that Hanna selected from irradiated dormant sprigs of Midiron, are several with much better turf quality. If they still possess the winterhardiness of Midiron, progress will have been made.

What about the other warm season species? Ray Dickens, Auburn, Ala., has released Centenial centipedegrass, a dwarf mutant produced by mutation breeding. Wayne Hanna has a number of interesting mutants of centipedegrass in material from repeated exposures to gamma irradiation. Ray Jensen, one of the major growers of centipedegrass seed, reports that he has found a centipedegrass that has a darker green color and produces more seed than the common centipedegrass generally grown today.

Because of its coarseness and continuous production of seed heads borne on stems 18 to 24 inches tall, we have rarely advised the use of bahiagrass for turf. However, it is widely used as a lawn grass in Florida, and makes a fairly good turf when mowed frequently. Its wide adaptation, ability to crowd out weeds and other grasses and ease of establishment from seed led to its use as a roadside grass by highway departments in Florida and Georgia. The high cost of energy required to keep it mowed, caused Percy Middlebrook, Georgia Department of Transportation, to encourage us to develop a turf bahiagrass for highway use. Shorter leaves and seed stalks than the Pensacola bahiagrass presently used was the main modification sought. Although we have made progress, we have nothing ready for release. We have reduced the leaf and stem length of the diploid sexual type but have not reduced it enough. By crossing a small tetraploid introduction that I found in Brazil in 1965 with the diploid Pensacola bahiagrass, we obtained a triploid with turf promise capable of producing some seed when pollinated with Pensacola bahiagrass pollen. From such pollinations have come a number of tetraploids with leaves and stems much shorter than Pensacola bahiagrass. Many appear to be apomictic, breed true, and seed reasonably well. Their turf will be coarse, but they should be easier and cheaper to mow and maintain as turf.

The genetic variability in St. Augustinegrass has permitted the development of a number of different cultivars, all propagated vegetatively. Floritam bred jointly by the University of Florida and Texas A and M University is resistant to chinch bugs and the SAD strain of the Panicum mosaic virus. Active breeding efforts with this species will most certainly produce better cultivars.

The genetic improvement of the Zoysia grasses by breeding should make this grass more useful in both the warm season region and the transition zone. Developing cultivars that can be established easily from sprigs or seed should be one of the main breeding objectives.

Carpetgrass, well adapted to low wet areas, can make a turf similar to centipedegrass when well managed. Its continuous production of seed heads some 12 inches tall makes a less attractive turf than centipedegrass when not mowed frequently. I know of no breeding work designed to improve the turf qualities of carpetgrass underway at the present time.

None of the warm season grasses used for turf are perfect. All of their weaknesses can be corrected in part, at least, by plant breeding. The success enjoyed by plant breeding to date warrants such optimism. All that will be required to improve our warm season turf grasses by breeding is work and the conviction that nothing is so good that it can not be made better.

A CONTEMPORARY VIEW OF THATCH IN TURF

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A turf profile typically includes at least three identifiable zones, including: aerial shoots, thatch, and soil. Of these, only the aerial shoot zone is composed entirely of living biomass, while the thatch and soil include both living and nonliving components. In newly established turfs, a thatch layer may be entirely absent, since the net accumulation of nonliving biomass, a probable precursor of thatch, has not yet developed. Following the accumulation of organic material at the soil surface, the living plant community responds by forming crowns, roots, and lateral shoots (rhizomes, stolons) within this medium. A thatch layer, composed of living and nonliving plant material, and located between the soil surface and aerial shoot zone, is thus formed. Due to its position within the turf profile and its relationship with the living plant community, the thatch is actually an important component of the growth medium of the turfgrass community. In some instances, growth of turfgrasses may be completely restricted to the thatch with virtually no roots or rhizomes extending to the underlying soil.

Thatch Formation

Thatch forms when organic debris from the actively growing turf accumulates faster than it decomposes. According to studies at the University of Illinois and elsewhere, cultural or environmental factors that stimulate excessive growth or impair decomposition are conducive to thatch development.

The actual sequence of events leading to the formation of thatch is not clear. Presumably, a relatively stable layer of organic material accumulates at the soil surface from clippings, senescent leaves, and aboveground adventitious rooting.

The turfgrass plants apparently respond by forming crowns, highly compressed stems at the base of aerial shoots, within this organic layer. (In a thatch-free turf, crowns form at or below the soil surface.) Adventitious roots and rhizomes emerge from mature sections of the crowns and start growing in the organic material.

Some of the crowns that develop in the thatch likely result from continued vertical growth of existing crowns. Others are formed by emerging rhizomes after they have been exposed to light and cease internode elongation. Since the thatch keeps light from penetrating to the soil surface, the internodes do not stop elongating until the rhizome terminal grows up to a level near the surface of the thatch.

As the older shoots and roots die, the crowns, roots, and rhizomes may eventually grow mostly within the thatch, rather than in the soil. Thus, where a substantial thatch has developed, it can constitute the primary growing medium for the turfgrass plants while the underlying soil is of only secondary importance.

Thatch characteristics

Thatch typically has a lower bulk density than either the underlying soil or the surface soil from a thatch-free turf. Since the soil underlying thatch contains few roots or rhizomes, it tends to be more compacted than thatch-free soils in which these organs grow extensively. This illustrates the favorable effects of root and rhizome growth on soil physical conditions.

The thatch layer may contain appreciable amounts of soil. Much of the soil may have been carried by earthworms to the turfgrass surface during the spring and fall. In intensively cultured turfs, soil can also accumulate in the thatch as a result of topdressing, core cultivation, and vertical mowing operations. The effects of incorporating soil into the thatch are currently under study. According to preliminary results, the addition of soil apparently increases bulk density of the thatch substantially. The soil also reduces the mobility of surface-applied fertilizer nutrients and pesticides. Since thatch is typically regarded as an organic medium that is essentially devoid of soil, the inclusion of soil in thatch results in a "hybrid" entity with entirely different physical and chemical properties.

Physically, thatch is analogous to sand in that it has large pores. This property means that thatch has better aeration than most soils, as well as better resistance to compaction under traffic. However, the large pores readily lose water from drainage into the underlying soil and evapotranspiration into the atmosphere. An additional problem is that upward water movement stops at the thatch-soil interface, where the continuity of capillary pores is disrupted.

Importance of Thatch in Turfgrass Culture

Because of the poor water-holding capacity of the thatch, and also because of restricted rooting, thatchy turfs are especially prone to wilting during long droughts. When completely dry, thatch repels water and is extremely difficult to re-wet. Consequently, thatchy turfs need more irrigation than thatch-free turfs.

The frequent waterings required on thatch turf tend to leach nutrients and pesticides through the thatch, so these materials have to be applied more often than on a thatch-free turf. Intensifying this need is the low nutrient storage capacity, or cation exchange capacity (CEC), of thatch. This low CEC does not show up if thatch is compared with soil on a weight basis. In fact, thatch samples had CEC measurements nearly twice those of equal weights of a silt loam soil. However, when these values were compared on an equal volume basis, the CEC of thatch was substantially lower than that of soil.

Another problem associated with fertilization of thatch turf occurs because soil-testing laboratories routinely discard the thatch before testing samples from turfgrass sites. Since most of the grass root system is in the thatch, the value of test results in determining fertilizer requirements is questionable. A valid test should include the thatch as part of the soil sample, or a separate analysis should be conducted for the thatch alone.

Pesticides applied to thatchy turf initially contact the thatch, rather than the soil. Thus, the mobility, metabolism and action of pesticides in thatch determine the efficacy, persistence, and selectivity of these chemicals. Attempts to characterize pesticide activity based upon studies conducted in soil media may lead to inaccurate conclusions when applied to turfgrass systems with thatch. Studies at the University of Illinois have shown that several preemergence herbicides are substantially more injurious to thatchy turf than to thatch-free turf. Laboratory studies have shown that these herbicides are more mobile in thatch than in silt loam soil. Thus, the herbicides are allowed to contact roots and rhizomes present in the thatch, but are held above these plant organs where they occur in soil in a thatch-free turf. This work has established two dimensions of turfgrass injury from preemergence herbicides: The inherent susceptibility of turfgrasses to injury from herbicides that contact their roots and rhizomes, and the accessibility of these plant organs to surface-applied

herbicides. For example, DCPA is an inherently safe herbicide. Even if it penetrates the root zone of a Kentucky bluegrass turf, little apparent injury results. Benefin, however, is an inherently injurious herbicide when allowed to contact turfgrass roots. In thatch-free turf, it is held above the root zone and, thus, causes no observable injury. Thus, the physical and chemical nature of the growth medium and the inherent susceptibility of plants to injury from specific herbicides together determine whether turfgrass injury will occur from herbicides applied to a specific site.

Thatch Control

In attempts to control thatch, various cultivation methods for extracting part of the organic debris without completely destroying the turf have been tried. These methods usually are not completely effective; they often injure the grass severely, and their beneficial effects may not last beyond one or two growing seasons.

However, one cultivation method, called coring or core cultivation, does alleviate soil compaction and improves infiltration in thatchy turfs. Small cores of soil are extracted to a depth 2 or 3 inches below the turf and are then dispersed and dragged into the turf, becoming part of the thatch layer. Although the thatch is not reduced uniformly through the turf, the thatch's physical and chemical properties are apparently modified. As a result, more moisture and nutrients are retained, and fewer fertilizer and irrigation applications are needed. Thus, this practice can conserve natural resources as well as improve turf quality.

DOES COMPACTION HAVE YOU BETWEEN A ROCK AND A HARD PLACE?

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Compaction is a phenomenon the professional turfgrass manager must learn to deal with if he intends to produce quality turfgrass on athletic fields, golf courses and other recreational surfaces. The effects of compaction are subtle, but significant. Our inability to understand the effect of compaction on the soil and plant will severely reduce our chance of producing quality turfgrass.

Compaction destroys soil structure, increasing soil bulk density, carbon dioxide concentrations, surface runoff, heat conductivity and small pore space. It decreases large pore space, soil aeration, water infiltration, percolation and nutrient and pesticide movement.

Bulk density is the mass of soil per unit of soil volume, including solids and the pore space. It is expressed in grams per cubic centimeter (g/cc) and ranges from 0.8 on well aggregated soils to above 2.1 on highly compacted soils. Bulk density values greater than 1.5 are generally indicative of soils compacted to the point where turfgrass root growth is seriously impaired. If increases in bulk density occur during periods when roots are actively elongating the damage can lead to poor development of root systems essential for summer survival.

Mechanical impedance or resistance to root or rhizome growth brought about by compaction is most severe on drier soils. The damage brought about by increases in mechanical impedance of soils is likely to be more severe on the clay and silt soils than on sandy soils because of the greater soil strength of heavier soils. This can result in shorter root and rhizome systems.

Plant roots need oxygen to survive and as the bulk density of a soil increases, carbon dioxide and other toxic gases evolving from respiration and organic matter decomposition meet increasing resistance to diffusion. Their concentration can build up to the point they become toxic to the root.

Since compaction is very much a surface phenomenon, most negatively affecting the top 4 inches of soil, surface runoff is significantly increased. Water use efficiency is decreased leading to greater irrigation demand. Infiltration, the passage of water through the soil surface, is, therefore, severely decreased by compaction. In the presence of poor surface drainage this generally leads to pooling of water in low areas and either suffocation of the turf or increased hydration of crown tissue leading to winter injury. Decreased infiltration rates that persist into summer make it extremely difficult to get water to the root-feeding zone during times of drought stress.

Increases in the heat conductivity of soils brought about by compaction lead to greater soil temperature extremes. The soil particles are packed closer together and the soil becomes a better conductor of heat. This means higher soil temperatures will be reached in the summer and lower soil temperatures in the winter. This means less rooting of the bentgrasses and bluegrasses at the higher temperatures. The increase in low temperatures, if severe enough, could result in slower root extension in the spring, lower root membrane permeability due to increased protoplasmic viscosity and reduced rates or water movement to roots because of increased water viscosity. The lower temperatures would also increase the likelihood of bermudagrass winterkill.

As compaction increases, the total volume of pore space in the soil decreases as does the size of the pores. Small pores are usually filled with water and retain this water with greater force than larger pores. Increased compaction increases the ratio of small to large pores and, therefore, on a volume basis, water begins to replace air in the soil profile. This leads

to low oxygen availability to roots. The roots need this oxygen to maintain their normal metabolic functions and to actively absorb nutrients from the soil solution. Pathogenic fungus organisms such as Pythium thrive in high soil temperatures in the presence of a lack of oxygen. The probability of summer disease problems is increased.

The decreased pore space brought on by compaction lowers the oxygen diffusion rate in the soil. Oxygen that was diffusing to the root through relatively large aeration pores before compaction must now diffuse in water at a rate 10,000 times slower. Weeds that can persist in low oxygen diffusion rates such as goosegrass and knotweed now gain the competitive edge over Kentucky bluegrass, creeping bentgrass and tall fescue.

Percolation is the movement of water through the soil profile. Water movement through the soil decreases as a result of the decreased infiltration rate and the decrease in pore size. As pore size decreases the resistance to water flow increases. Once a compacted soil is wetted the increased amount of small pores retain more water per unit volume than an uncompacted soil. Therefore, greater amounts of time are required to dry the surface. The small pores in compacted soil hold the water with greater force than large pores and even though the soil retains more moisture than it did prior to compaction, a greater portion of the water is unavailable to the turfgrass plant.

As compaction increases, it becomes increasingly difficult to get applied nutrients to the roots. Compaction significantly reduces root growth in the surface 4 inches, and the uptake of relatively immobile elements such as phosphorus, calcium, magnesium and potassium is severely affected. When pesticides require soil mobility for effectiveness; for instance, in the case of grub control or root uptake of some systemic fungicides, compaction can significantly reduce efficacy.

All of these individual negative effects of compaction on the soil work together to impart a very

negative total effect on turfgrass growth and quality. Decreased root, shoot, tiller, rhizome and stolon growth results from compacted soil. Nutrient uptake in the turfgrass plant is altered with certain elements being more affected than others. Nutrient uptake of potassium, nitrogen, phosphorus, calcium and magnesium are most negatively affected by compaction. The turfgrass plant growing on compacted soil is less able to produce stored food reserve. Fifty percent reductions in total nonstructural carbohydrates have been noted in research on compacted Kentucky bluegrass when contrasted with uncompacted areas. Research has also shown that while plant succulence increases on compacted turf, total water use tends to decrease as a result of the decreased density and vigor of the turf. Wilting frequency is increased because the moisture in a compacted soil is retained by smaller pores with increased force, and applied water is less efficiently absorbed. The tendency of a turf to wilt more frequently leads most turf managers to increase irrigation frequency at increased labor and water expense. As irrigation frequency increases annual weed competition increases from knotweed, crabgrass, and goosegrass. Excessive plant succulence and aerobic soil conditions predispose the plant to disease activity. The turf manager quickly finds himself needing more herbicides and fungicides to compensate for what is basically a problem being caused solely by soil compaction.

Problems such as high and low temperature injury, sun scald, dry wilt and drought, wet wilt, intracellular freezing and winter dessication can often be traced to compaction.

Managing turf to minimize the negative effects of compaction is important. Management considerations helpful in this regard are aerification, traffic control, water management, soil modification, efforts to improve drainage and irrigation design and turfgrass selection.

Core aerification is extremely beneficial in increasing air exchange, water infiltration rates, water retention, nutrient penetration and thatch decomposition. It also decreases surface runoff and

therefore increases water use efficiency, reducing total irrigation requirements. Heavily trafficed cool-season grasses should be aerified spring and fall during periods of active foliage growth. Mid-summer aerification can be beneficial if irrigation is available and temperatures are favorable. Warm-season grasses can be benficially aerified from the time they green up till they go dormant in the fall. Once a month aerification on heavily trafficed bermudagrass would not be detrimental. Total number of aerifications per year needs to be linked to fertility levels, amount of traffic and thatch buildup present. Two to five aerifications per year should be considered average for heavily-trafficed recreational turf.

Minimizing taffic whenever possible is important. Limiting play on main fields to essential use only is critical. Minimizing traffic when soil is wet is critical. Compaction damage is greater on a wet soil than on a dry soil. At a given soil moisture content light equipment will cause less damage than heavy equipment. Therefore, timing irrigation to allow adequate time for drainage prior to traffic can be a critical factor in reducing compaction damage.

Amending soils with sand is difficult and seldom successfully accomplished with on site incorporation. Off-site blending of sand and soil to achieve maximum compaction resistance and yet retain adequate moisture and nutrient holding capacity is the best approach to soil modification. Laboratory testing to confirm the proper ratio of sand, soil, and peat is essential to success.

Since wet soils are damaged more by compaction than dry soils, obviously any attempt to maximize drainage efficiency is beneficial. Good surface and internal drainage are esential to minimizing the negative effects of compaction. Inadequately designed irrigation systems will frustrate any attempt to win the battle with compaction. Moisture delivery needs to be easily programmable, uniform in pattern and capable of being matched to the soil infiltration and percolation rate.

Selecting turfgrasses that are traffic tolerant is extremely important. There is mounting evidence that the improved perennial ryegrasses are more traffic tolerant than Kentucky 31 tall fescue. Their intensive root development, quick germination and recuperative potential have made them excellent athletic field grasses in areas where they are adapted. Mixtures of Kentucky bluegrass and perennial ryegrass are performing well under moderately heavy traffic, especially when aerified. Bermudagrass remains an outstanding grass for athletic field surfaces in southern Virginia and most of North Carolina.

It is esential that recreational turf managers develop total turf management programs that effectively deal with the negative impact of compaction. Failure to realize that compaction is a subtle but deadly detractor of turf quality will certainly lead to frustration and failure. Deal with compaction - don't put yourself between a rock and a hard place.

ESTABLISHMENT OF COOL SEASON LAWNS IN PIEDMONT NC

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If one looks at a turfgrass adaptation map, piedmont North Carolina is in the transition zone. That means that temperatures average too low in winter for warm season grasses and too high during summer months for cool season grasses to perform very well. The native species of grasses in this area are crabgrass and broomsedge.

These native grasses are not desirable for quality turf. We know from years of research and experience that tall fescue is a grass widely adapted to the transition zone. Tall fescue is a cool season grass and performs best in the fall, winter and spring - the cool seasons of the year. During summer tall fescue naturally goes into a resting conditon. I believe that developing a strong, deep root system in the heavy piedmont clay soils during the fall, winter and early spring is the secret to tall fescue being able to survive during heat and moisture stress periods.

Most soils in the piedmont are acid on the pH scale, with 5.5 - 5.7 being the average in Mecklenburg County. Tall fescue needs a pH range of 6.5 - 7.0 for nutrients to be readily available and for the roots to be able to penetrate deeply into clay soils. Adding lime according to a soil test report can change the soil pH to a desired level. Ideally lime should be incorporated into the soil at seed bed preparation time so as to modify soil pH where the roots should be developing. However, most lime is applied to the soil surface. It may take several years for lime to move into the potential root zone when surface applied to heavy clay soils. Fall and winter lime applications may facilitate lime moving into the soil more readily.

Lime is not a fertilizer, but without lime in acid clay soils nutrients are not totally available. Take a soil with a pH of 5.0 for example. Only 53% of N, 34% of P, and 52% of K are available compared to the availability at pH of 7.0. Soil should be tested every two years to monitor pH and maintain desirable pH levels.

In addition to being acid, most soils in the piedmont are low in phosphorus. Again, a soil analysis will tell you what kind of fertilizer to use and how much. Usually a starter fertilizer or a complete field grade fertilizer, such as 10-10-10, is used for establishing fescue lawns. But don't guess, soil test.

Like lime, phosphorus fertilizers must be worked 4 to 6 inches into the soil for maximum root development. Keeping the soil pH in the proper range also makes phosphorus more available to the grass.

For new lawns, the soil should be broken up to a depth of 6 to 8 inches to relieve compaction and remove debris in soil. Lime and a complete fertilizer carrying phosphorus applied according to a soil

test report should be incorporated 4 to 6 deep into the soil. This seed bed preparation is a must to promote deep root development.

After fine grading and raking have been completed apply tall fescue seed evenly at the rate of 5 to 7 pounds per 1000 sq. ft. of area. Although Ky 31 tall fescue has been the standard for years, the turf-type tall fescues like Rebel, Falcon and Clemfine are gaining in popularity. Other speakers will elaborate in more detail on turf-type tall fescues. Very little if any covering the seed is necessary on prepared soil. The optimum time for seeding is Labor Day until early November. Most turf experts agree that spring seeding should be avoided if possible, due to lack of root development as temperatures increase. Disease problems are worse on Spring seeding also.

If possible, use straw to cover seeded areas. Clean wheat straw is best and should be applied at the rate of 1½ bales per 1000 sq.ft. The straw should not be removed when the new grass comes up. It will decompose into the soil.

Water in addition to temperature is needed to start the germination process. If irrigation is available, keep the upper 2 inches of soil moist until the seedlings are growing. It is best not to keep new seedlings wet during the night time. Once the grass is established, practice deep, infrequent watering to encourage deep roots.

Mowing new grass is important. Set the mower blade a minimum of 2½ inches; 3 inches is better during hot weather. Make certain the blade is sharp to prevent tearing grass blade ends and pulling new seedlings out of the soil. There is a relationship between how high grass is mowed and how deep roots can penetrate the soil. Again, mow high to encourage strong root development.

Contrary to popular opinion, it is not necessary to remove clippings on tall fescue turf. Clippings will recycle nutrients and eventually humes back into the soil.

ROTARY SPREADER CALIBRATION

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One of the most frequent causes of misapplication of granular products in the professional turf industry is the lack of calibration of the rotary spreader.

It behooves the turf professional to learn how to properly calibrate spreading equipment rather than depending upon someone else's settings or using the setting he thought he used last year. This article will be directed toward calibration of rotary spreaders, with emphasis on those units which have a pattern adjustment capability. Those rotary spreaders without pattern adjustment have a tendency to produce off-center patterns. With these units, use of a blocking device (such as packing tape) is necessary in lieu of a pattern adjustment slide.

Two aspects of product application must be considered when calibrating any spreader. First, is the product application rate, or i.e. the amount of product that is to be applied per thousand square feet. The application rate is particularly important because over application can be costly and may cause plant injury, and under application may substantially reduce the effectiveness of the product.

Second, and of equal importance is the distribution pattern of the spreader. The pattern of a rotary spreader is dependent on impeller characteristics (height, angle, speed, shape, roughness), ground speed, drop point of the product on the impeller, product density and shape, and environmental factors (temperature and humidity). The operator does not have control of all of these factors, but we will discuss those aspects of spreader operation that the operator must consider for proper spreader calibration.

LABEL SETTINGS on any product should only be used as the initial setting for trial runs by the operator, prior to large scale use of the spreader. Calibration should be checked periodically, at least once a month or more often when the spreader is used frequently. The operator may follow these steps for correct spreader calibration.

A. Check spreader discharge holes with operating lever in the closed position. If the discharge holes are not fully closed, thread the upper lock not on the operating lever rod further up the rod. Retighten lower jam nut and recheck. Repeat procedure until holes are fully closed.

B. Adjust "pattern slider" to provide a uniform product distribution across the full pattern. A quick pattern check can be made by operating the spreader over a paved area and observing the pattern. A more accurate method is to lay out shallow boxes or pans in a row on a line perpendicular to the direction of spreader travel.

Boxes 2" high placed on one foot centers work well. To conduct the test begin with the "pattern side" completely open. Close the operating lever and set the rate adjustment at "S". Make three passes over the boxes operating in the same direction each time. The material caught in each box may be evaluated (weighing is most accurate method) to determine uniformity. An easy method is to pour the contents of each box into a small vial or bottle setting them side by side in order. The pattern variation, using this method, is quite visible. To reduce the amount of discharge to the right hand side (operator's right) with products such as sulfur coated urea, it may be necessary to completely close the "pattern slide" to provide a uniform pattern.

C. Determine application rate adjustment as follows:

1. Set rate adjustment at approximate setting - possibly a starting point supplied by your manufacturers representative or from a suggestion on the bag.

2. Make a trial run to determine the effective width of the pattern using the collection boxes. The effective pattern width is twice (2 x) the distance out to the point where the rate drops to one-half the average rate at the center. Example: If the material in the vials in the center boxes average two inches in depth, count out to the vial which has one inch of material. If this is the 5th vial from the center (boxes were on one foot centers) the effective pattern width is 10' (5 x 2). Using this method for determining effective pattern width proper overlap is achieved.

3. Now knowing the effective pattern width (10'), measure out a lineal distance equal to 1,000 sq. ft .(100' x 10' equals 1000).

4. Weigh out some of the product (20 lb.), empty it into the spreader. Have the operator spread the product over the distance (See number 3) necessary to equal 1,000 sq. ft. and then weigh the product again to determine the actual rate of delivery. Adjust the rate adjustment up or down as needed and repeat the process until the correct rate of delivery is achieved. Keep in mind that different operators will push the spreader at variable speeds. Spreaders should be adjusted to an individual operator.

D. Basic Do's and Don'ts:

1. Always push the spreader; do not pull.

2. Push the spreader at a consistent speed approx 3 mph recommended.

3. Always close operating lever before filling hopper.

4. Be sure screen is in place.

5. Always start forward before opening ports; close ports before forward motion is stopped.

6. Hold handle at a height that will keep the impeller level.

7. Empty spreader after each use. Wash spreader thoroughly and allow to dry. Keep impeller blades clean.

8. Lubricate all moving parts.

WEED MANAGEMENT IN LAWNS

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A weed management program is based upon identifying the desired turfgrasses and existing weeds, including a knowledge of other weeds which may potentially germinate. However, an effective program begins with a vigorous turf, one that has been correctly fertilized, watered, and mowed. Weeds quickly invade thin turf. Cultural and management practices that enhance turfgrass growth generally reduce weed competition and encroachment. When selecting a herbicide, consider the weeds present, those that will potentially germinate, and the tolerance of the turfgrass.

Selection of adapted turfgrass species and cultivars and the use of cultural practices are important in minimizing weed encroachment and competition. Management practices include: 1) mowing at the recommended height for the selected turfgrass and removing clippings when seedheads of grassy weeds are present; 2) applying the proper amount of nitrogen at the correct time according to the turfgrass present; 3) utilizing soil tests to determine needed potassium, phosphorus and lime; 4) avoiding power raking and aerifying after preemergence herbicides have been applied; and 5) applying preemergence herbicides before weeds germinate.

Listed in tables 1 and 2 are herbicides which are labeled in specific turfgrasses for preemergence control of primarily annual grassy weeds. The tolerance of cool-season and warm-season turfgrasses to postemergence applied herbicides is given in tables 3 and 4. These listings should be helpful in selecting the proper herbicide for the turfgrass being grown.

Table 1. Preemergence herbicides for cool-season turf

	Bluegrass	Tall Fescue	Perennial Ryegrass
Smooth and large crabgrass, goosegrass, foxtails, annual bluegrass			
Benefin	+	+	+
Benefin + oryazlin (XL)	+	+	+
Bensulide (Betasan)	+	+	+
DCPA (Dacthal)	+	+	+
Oryzalin (Surflan)			
Oxadiazon (Ronstar G)	+	+	+
Pendimethalin (So. Weedgrass Control)		+	
Simazine (Princep)			

+Labeled for use

Table 2. Preemergence herbicides for warm-season turfgrasses

	Bermuda-grass	Centipede-grass	St. Augustine grass	Zoysia
Smooth and large crabgrass, goosegrass, foxtails, annual bluegrass				
Benefin	+	+	+	+
Benefin + oryzalin (XL)	+	+	+	+
Bensulide (Betasan)	+	+	+	+
DCPA (Dacthal)	+	+	+	+
Oryzalin (Surflan)	+			
Oxadiazon (Ronstar G)	+		+	+
Pendimethalin (So. Weedgrass Control)	+	+	+	+
Simazine (Princep)	+	+	+	+
Annual bluegrass and winter annual broadleaf weeds				
Atrazine	+	+	+	
Simazine (Princep)	+	+	+	+

+Labeled for use

Table 3. Tolerance of turfgrasses to postemergence herbicides for broadleaf weed control

	2,4-D	Mecoprop	Dicamba	Bromoxynil
Cool season				
Bentgrass	S-I	T	I	T
Tall fescue	T	T	T	T
Red fescue	T	T	T	T
Kentucky bluegrass	T	T	T	T
Ryegrass	T	T	T	T
Warm season				
Bahiagrass	S-I	T	T	-
Bermudagrass	T	T	T	T
Centipedegrass	S-I	I	I	-
St. Augustinegrass	S-I	S-I	S-I	T
Zoysiagrass	T	T	T	-

T = Tolerant
I = Intermediately tolerant, use with caution, use at reduced label rates, or minimum label rates
S = Sensitive, do not use this herbicide

Table 4. Tolerance of turfgrasses to postemergence herbicides for grass and broadleaf weed control

	DSMA, MSMA, CMA	Atrazine	Kerb	Basagran	Roundup
Cool season					
Bentgrass	I	S	S	T	S
Tall fescue	I	S	S	T	S
Red fescue	I	S	S	T	S
Kentucky bluegrass	I	S	S	T	S
Ryegrass	T	S	S	T	S
Warm season					
Bahiagrass	S	S	S	T	S
Bermudagrass	T	T	T	T	D
Centipedegrass	S	T	S	T	S
St. Augustinegrass	S	T	S	T	S
Zoysiagrass	I	T	S	T	S

T = Tolerant
I = Intermediately tolerant, use with caution, use at reduced label rates, or medium label rates
D = Only dormant grasses tolerant

Human Relations as a Management Tool

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The central focus of this presentation was to emphasize the importance of both "concern for production" and "concern for people". Dr. Penland utilized a managerial grid developed by Robert Blake and Jane Mouton to describe basic management styles. The Blake and Mouton grid is a two-dimensional leadership model with one axis labeled "concern for production" and the other labeled "concern for people". Each axis is calibrated from one to nine in degrees value. The combination of values from each axis demonstrates that typical managerial style that might exist. Dr. Penland demonstrated managerial styles that ranged from "9-1" high concern for production and little concern for people to the "1-9" high concern for people but little concern for production.

The audience was quickly made aware of the problems that exist with any management style that is not balanced with some degrees of both variables.

Dr. Penland placed a lot of emphasis on the fact that in the Turfgrass business we sometimes have a tendency to concentrate more on production and forget about good human relations techniques. In summary, it was strongly emphasized that increased and/or improved human relations might well increase efficiency and commitment from the employee. Consequently, we can clearly see that good human relations combined with concern for production can increase profits and financial success.

PUBLIC RELATIONS FOR LAWN CARE COMPANIES

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An area of public relations that needs to be addressed due to the existing and future trends of the industry is public image or how the general public views our service. Everyone is aware of the pressure being put on the lawn care industry and other related industries by private interest groups -- that VIEW our service as unsafe environmentally. They are relentless in their search for a scam that will help back their cause with the ultimate goal to put you, the professional lawn person, out of business. That may seem strong, but it is strong and it's real.

The lawn care industry has gotten to where it is today by having an excellent professional image, and offering a service that is both beneficial and under-priced. With the exception of price, we need to continue this image we have obtained by (1) not taking the basic rules of good image for granted, and (2) not presume things are being done right when they're not. These things are: clean trucks; neat, educated technicians; and safe practices in all areas of lawn care.

Try to picture this: You are a neighbor of a house that is being serviced by a lawn care service. You have read about all the dangers of pesticides coming up in the news lately, but you really wonder if its true. That day a large tank truck pulls up next door to service your neighbor. You step outside for a look -- the truck is nice and clean and seems to be well kept. The man steps out of the truck, well uniformed, neat and clean, and proceeds to service the lawn.

Everything looks safe enough, but let me pull this guy aside and ask him a couple of questions. "Hey, what are you spraying there?" The technician stops immediately after he finishes the pass across the lawn. He's thinking, "Boy, I've got a sure field sale here. That's five bucks commission money for this weekend." He replies, "Fertilizer for winter root growth and weed control -- to control germinating winter weeds." Then you question "Is it safe?". "Absolutely!" the specialist replies. "All products we use in our service are safe -- controlled by the state Department of Agriculture and EPA. With the

testing and training we go through before spraying a lawn, it's much safer than doing it yourself."

The point here is, the technician was not 'shooting from the hip'. His equipment was clean, he was sharp, and he knew if he said the 'right' thing, he probably would get a sale.

Contrast that with this scenario: You again are looking out of your window. A large, corroded truck pulls up, barely supporting a heavily rusted spray tank with chemicals caked on or leaking from it. The shirtless lawn specialist or, in this case, 'spray jockey', is using the glug method to mix some chemical that he has stored in an unlabeled milk jug in his spray tank. You watch in horror -- "My gosh, it's true", you say. "Something must be done about this or we will all be killed. I'll bring this up at the next community meeting." When you do, SOMETHING WORSE HAPPENS. Another neighbor stands up and says, "I talked to that spray guy and asked him what he was spraying and he said 'I DON'T KNOW. IT JUST KILLS THINGS.'" The next morning, THE GOVERNOR GETS CALLED.

THIS STUFF HAPPENS! I've seen it happen, you've seen it happen. This may be a slight exaggeration. It does happen, probably in less than 1/10 of 1% of the cases, but that's enough to cause problems for our industry.

Have you heard of Bon Ve Von vegetables and soups? They were once a large marketer of canned goods until one can of Vishysuo soup with botulism caused the death of the cook, a wife, a mother. Could Bon Ve Von pay off the law suit? Probably. Would they every recover from the bad press and public relations? NO. ONE CAN OF SOUP was death to that company. Can you imagine what one freak accident could do to us?

UNION CARBIDE -- Need I say more? Law suits have been filed and world public relations have suffered.

OUR IMAGE IS IMPORTANT. Image alone won't protect us from the grasp of our adversaries but it is an important step that we must continue to strive for. Don't ignore the obvious and I might add, don't 'bad mouth' these private interest groups. They are also serving society in a way that is right in their own hearts, and they keep us in line.

LATE FALL FERTILIZATION

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The trend toward late fall fertilization of cool-season turfgrasses continues to grow in popularity way beyond its original area of development. The method of applying 70 to 100% of the nitrogen on cool-season grasses from September through December has primarily developed from research and practical observations made on the management of Kentucky bluegrass in the Mid-Atlantic transition zone of the United States. The development of the practice, as with any new idea, has had diverse origins. Significant contributions to the understanding of the principal of late fall fertilization have been made by Dr. Roy E. Blaser, Professor John F. Shoulders, Dr. R. E. Schmidt, Dr. A. J. Powell, Jr. and others. The practice appears to be beneficial to other grasses such as tall fescue, creeping bentgrass, fine fescues and perennial ryegrasses. The practice has now been beneficially utilized throughout the Eastern half of the United States wherever cool-season grasses are grown.

The philosophy has evolved from research and practical observations indicating that excessive spring fertilization often leads to summer death of the cool-season grasses in the climatic transition zone of the United States. Research and practical observations indicate that nitrogen is the most plant responsive element in turfgrass management. We know it increases general growth rate, shoot elongation, density, color, recuperative potential, and competitiveness. It can also have the effect of decreasing resistance to certain diseases as well as reducing heat, cold, and drought tolerance.

The theory of late fall fertilization is primarily dependent upon differences which exist in three metabolic processes called photosynthesis, photorespiration and respiration. The process of

photosynthesis utilizes carbon dioxide in the presence of sunlight, chloroplasts and water to produce carbohydrate. This carbohydrate can be utilized immediately or serve as a food storage product. The light fixation process of photosynthesis (formation of carbohydrate) is relatively temperature insensitive in that it occurs almost as rapidly at 40 degrees as it does at 70 degrees. The process of photorespiration, which is temperature dependent and linked directly to the photosynthetic process, appears to be, for the most part, a wasteful, temperature-dependent process most active at high temperatures. It is commonly found in cool-season grasses, but not in warm-season grasses such as bermudagrass, crabgrass or goosegrass. Researchers have shown that 15 to 50% of the photosynthate produced can be used in photorespiration with no apparent contribution to food production in the plant. The process called respiration utilizes the photosynthetically produced food for growth and processes and is very temperature sensitive and also most active at high temperatures. So both respiration and photorespiration are processes that will peak during high temperatures and burn maximum amounts of photosynthate. This means that in most areas where temperatures frequently exceed 85 degrees, Kentucky bluegrass is in a state of "deficit spending" with regard to stored food reserves. In other words, it is burning up more carbohydrate in respiratory processes when temperatures are excessively warm, than it can make in the photosynthetic process. Therefore, forcing bluegrasses or other cool-season grasses to grow with excessive nitrogen during these periods when deficit spending can occur, can predispose plants to summer death. Excessive summer fertilization of Kentucky bluegrass and other cool-season grasses in the climatic transition zone of the United States can result in excessive foliar elongation, loss of stored food reserve and predisposition to disease attack.

In many regions of the United States, nitrogen fertilization of cool-season grass during periods when photosynthesis is maximum and photorespiration and respiration are minimal (late fall) can lead to maximum carbohydrate production and storage of food reserves. These food materials are then utilized during the winter growing season for the production of roots in

lieu of leaf production. These same food reserves can be utilized to provide recuperative potential during midsummer heat stress. Carbohydrate storage is maximum during the winter and early spring, and root growth begins in the fall and peaks in early spring. The foliar growth rate is medium in the fall and minimum in the winter with a maximum peak in late spring. During the spring period of rapid top growth, considerable depletion of carbohydrate food reserve can occur. At this time of rapid increase in leaf elongation, root growth essentially stops. It appears that nitrogen fertilization during this period of rapid top growth has the very negative effect of decreasing food reserves in the plant. This improper timing of nitrogen fertilization can leave the plant going into summer in a "carbohydrate deficient" status which can lead to eventual weakening of the plant if excessive heat forces "deficit spending" for extended periods of time.

Obviously, in some areas of the United States there is no harm done in fertilizing cool-season grass throughout the summer. In these areas, there is very little, if any, "deficit spending". As one moves north from the 4,400 total growing degree day line, shown in Figure 1 the necessity for late fall fertilization diminishes. In the area of the 4,400 degree day line, late fall fertilization is almost a necessity for summer survival of cool-season species. As one moves north of the 3000 total growing degree day line, the necessity for, and the benefits of late fall fertilization most likely diminish.

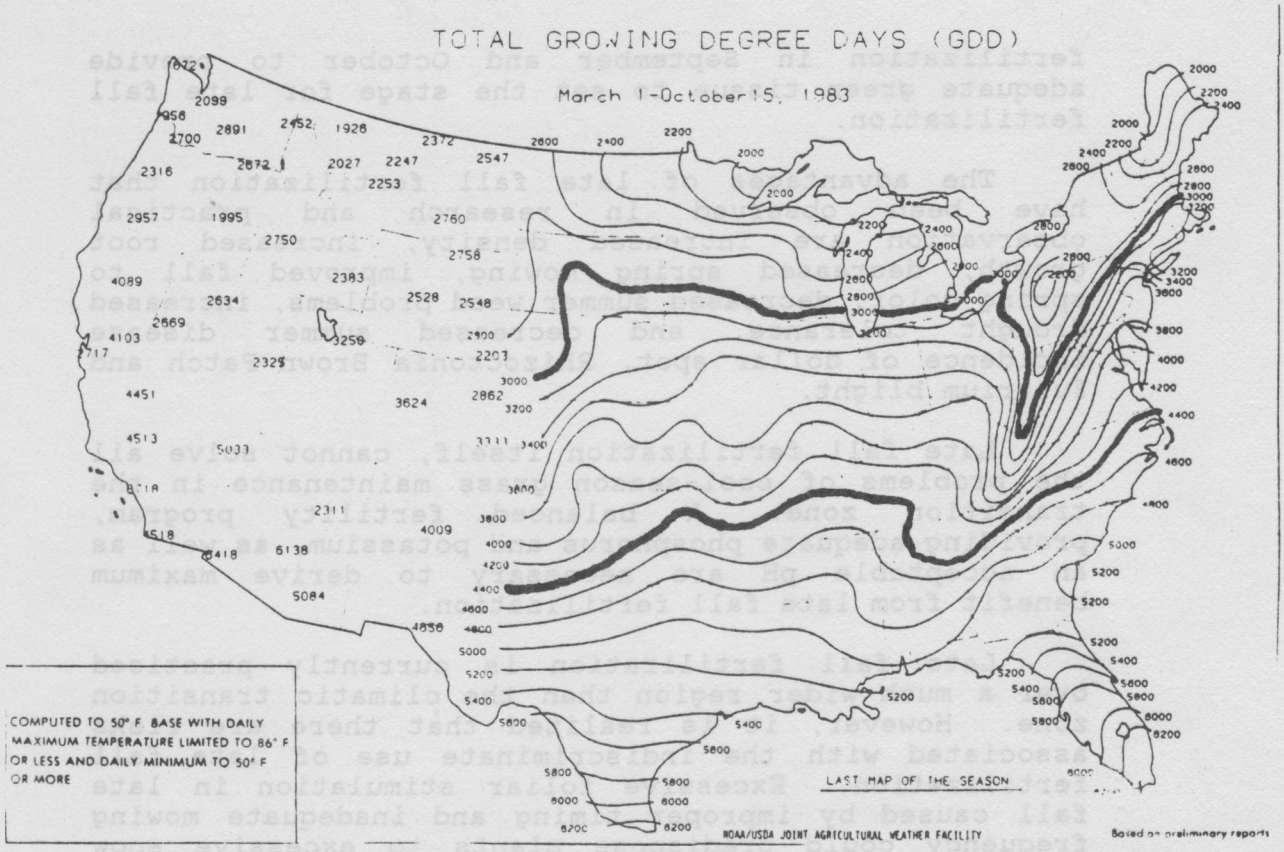

Figure 1. Total growing degree days in the United States from March 1 to October 15, 1983. Taken from USDA Weekly Weather and Crop Bulletin, October 18, 1983.

The success of late fall fertilization is very much dependent on proper timing of the nitrogen applications. The greatest benefit of late fall fertilization has occurred where relatively soluble sources of nitrogen have been applied during that time period in the late fall when their application results in very little if any shoot production, and adequate chlorophyll containing green tissue exists to produce carbohydrates. In Virginia, this is generally between November 15 and December 15. The late fall fertilization concept needs to be supported with

fertilization in September and October to provide adequate green tissue to set the stage for late fall fertilization.

The advantages of late fall fertilization that have been observed in research and practical observation are increased density, increased root growth, decreased spring mowing, improved fall to spring color, decreased summer weed problems, increased drought tolerance, and decreased summer disease incidence of dollar spot, Rhizoctonia Brown Patch and Fusarium blight.

Late fall fertilization itself, cannot solve all the problems of cool-season grass maintenance in the transition zone. A balanced fertility program, providing adequate phosphorus and potassium, as well as an acceptable pH are necessary to derive maximum benefit from late fall fertilization.

Late fall fertilization is currently practiced over a much wider region than the climatic transition zone. However, it is realized that there are risks associated with the indiscriminate use of late fall fertilization. Excessive foliar stimulation in late fall caused by improper timing and inadequate mowing frequency could predispose plants to excessive snow mold and winter disease injury. Therefore, it is important that individuals contemplating late fall fertilizatin outside of the transition climatic zone be aware of the importance of timing and mowing with regard to deriving the benefits of late fall fertilization. Whether the benefits to be derived from late fall fertilization are sufficient to merit consideration, needs to be determined by each individual in his particular environment. No professional should jump into a new management program such as this without experimentation on a small scale under local environmental conditions.

There are considerable benefits to be derived from late fall fertilization if it is properly used. If you are currently having difficulty keeping cool-season grasses alive in mid-summer with your management program, it may be beneficial for you to experiment with late fall fertilization.

MAINTENANCE OF ATHLETIC FIELDS

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Sound maintenance practices are just as important as proper establishment in ensuring the development of a dense, wear resistant turf that will provide firm footing, pleasing appearance and some degree of safety for those using it. The type of maintenance employed will depend primarily on whether the field is composed of warm season (bermudagrass) or cool season (tall fescue, Kentucky bluegrass) grasses. Tall fescue planted alone or in combination with Kentucky bluegrass is best suited for the mountain region and portions of the Piedmont while bermudagrass is the preferred choice for the remainder of the state. The following management schedules presented, one for warm season and one for cool season grasses, are designed to help produce and maintain the type of grass necessary for good athletic fields.

BERMUDAGRASS ATHLETIC FIELDS

MOWING. The best mowing height during the growing season is 1 inch for common bermudagrass and between 3/4 to 1 inch for hybrid bermudagrass. (There are two exceptions: 1) in early spring, PRIOR TO GREEN UP, the mower should be set very low to remove debris and 2) at the end of the growing season when the height should be raised to about 1 1/2 inches so as to insulate against low temperatures and increase tolerance to wear.)

Fields should be mowed as often as required so as not to remove more than 30 to 40 percent of the foliage, that is, do not allow bermudagrass to grow above 1 1/2 inches between mowings when mowing at one inch. Clippings rarely need to be collected if this schedule is followed. If grass grows excessively high during wet seasons, raise the mower and cut off 1/4 to 1/2 the present growth; then, lower the mower to its proper height in a day or two.

Reel mowers are preferred to insure a clean, high quality cut. Rotary mowers are a second choice provided they possess a sharp balanced blade and can be lowered to the appropriate height.

FERTILIZATION. Soil test results should be used annually to determine your phosphorus, potassium and lime requirements. A soil sample kit can be obtained by contacting your local agricultural extension agent. There

is no fee for this service. A complete fertilizer with a 4:1:2 or 3:1:2 ratio can be applied at least once during the growing season in the absence of a soil test; however, this is a poor substitute for a soil test.

Bermudagrass should be fertilized every 4 to 6 weeks at 1 to 1 1/2 pounds of nitrogen per 1000 square feet beginning two weeks after initial green up and continuing through to September 1 for turf grown in the Coastal Plain and Eastern Piedmont. Fertilizers containing slow release nitrogen can be applied at higher rates and less frequently. The suggested cutoff date for areas further north and west will be 1 to 2 weeks earlier while areas further south and east will be several weeks later. Unless the bermudagrass is overseeded with cool season grasses, do not fertilize bermudagrass in the fall or winter to avoid turf loss from winter kill.

A high potassium fertilizer applied toward the end of the growing season to provide a pound or two of potassium (K20) per 1000 square feet, yet very little nitrogen, will enhance bermudagrass cold tolerance.

IRRIGATION. Early morning is the preferred time to water. This will minimize potential disease problems, water loss through evaporation and poor water distribution due to wind. Water to a depth of 4 to 6 inches. Avoid watering the field again until signs of wilt (rolled leaves, bluish green color and foot printing) are apparent. Soil cores can be examined to determine if soil is dry and plants are in need of water. Light, frequent waterings promote shallow roots and a weakened turf. Avoid irrigating 2 to 3 days prior to heavy use to reduce compaction.

SOIL CULTIVATION. Vertical mowing for thatch (dead plant residue) removal is essential for bermudagrass especially fields that are planted to hybrid bermudagrass. Run a vertical mower (power rake) set so as to just cut the soil surface (no more than 1/4 inch deep) 2 to 3 weeks after spring green up and again in mid-summer. This will help remove thatch. Run the verticutter twice over the field at right angles to each other and sweep and haul off the debris.

Aerification (coring) alleviates compaction and is necessary on athletic fields receiving heavy traffic. Aerate monthly using 3/4 to 1 inch tines THAT REMOVE SOIL CORES beginning 2 weeks after green up and prior to fertilization. Aerate the field lengthwise twice and crosswise once for each aeration treatment. Allow the plugs to dry, then pulverize them with a mower or power rake and redistribute with a dragmat.

Plan to rent, borrow or contract these services out if you do not have this equipment on hand. Soil cultivation practices are a must to obtain an acceptable field.

PEST MANAGEMENT. Weeds are seldom a problem in healthy, dense vigorous turf; however, excessive wear and compaction from heavy traffic can result in weed encroachment. Annual grassy weeds are best controlled using preemergence herbicides applied in the spring. They should be applied by the time the dogwoods are in full bloom. Delay application by two weeks where only goosegrass is a problem. Some preemergence herbicides may retard growth of bermudagrass in the spring. Selective herbicides such as 2 or 3 way combinations of 2,4-D; 2,4-DP; MCPP and dicamba can be spring applied to control broadleaf weeds. Some broadleaf weeds are best controlled using products applied twice at one-half the labelled rate ten days apart. Certain non-selective herbicides such as Glyphosate (Roundup) can be used on DORMANT bermudagrass for the control of certain weeds. Arsonates can be used to control summer grassy weeds in bermudagrass.

Diseases and insects are seldom a problem on properly maintained athletic fields. If you suspect a disease or insect problem, make sure you correctly identify the pest before applying any pesticide. Contact your extension agent if you need assistance. (Oftentimes, a pest problem is an indication that changes in the turf management program currently employed are necessary.) If pesticides are warranted, select the most appropriate, read and follow label directions. Reference manuals such as North Carolina Agricultural Chemicals Manual and the recently released Turfgrass Pest Management Manual can help pinpoint the cause and determine appropriate control measures.

OVERSEEDING. Fields used late in the fall or early spring should be overseeded to provide color and protect the dormant bermudagrass. Seed areas approximately 20 days before the first expected frost and perform the following operations prior to seeding on heavily trafficked areas:1) Conduct a soil test to determine nutrient needs, 2) Drop mowing height by 1/2 inch, verticut (power rake) to remove thatch and sweep the area, 3) Fill sunken areas with original root zone mixture and aerify and pulverize the cores.

Seed using annual or perennial ryegrass (10-20 pounds per 1000 square feet) which should be applied in two directions (at right angles) and work in with a dragmat. Topdress intensively managed areas, drag the area and delay the incorporation of nutrients for several weeks. Water twice daily for 7-10 days and gradually reduce frequency and increase duration as seedlings become established.

Begin mowing about two weeks after planting at appropriate (infield = 1/2 inch; outfield, football, soccer = 1 inch) height. Keep extra seed on hand to patch worn areas. Fertilize monthly (except January) at 1/2 pounds of nitrogen per 1000 square feet.

TALL FESCUE AND KENTUCKY BLUEGRASS

MOWING. Maintain bluegrass at 2 to 2.5 inches and tall fescue and tall fescue/bluegrass mixtures at 2.5 to 3 inches. The higher height of cut should be imposed from late spring to early fall to enhance deep rooting and healthier plants.

Fields should be mowed as often as required so as not to remove more than 30 to 40 percent of the foliage, that is, do not allow tall fescue and Kentucky bluegrass to get above 4 and 3 inches respectively between mowings. Clippings rarely need to be collected if this schedule is followed. Remove only clippings that windrow. If grass gets excessively high during wet seasons, raise the mower and cut off 1/4 to 1/2 the present growth; then, lower the mower to its proper height in a day or two. Make sure the rotary mower has a sharp, balanced blade to prevent leaf frazzling.

FERTILIZATION. Annual soil test results should be used annually to determine your phosphorus, potassium and lime requirements. A soil sample kit can be obtained by contacting your local agricultural extension agent. There is no fee for this service. A complete fertilizer with a 4:1:2 or 3:1:2 ratio can be applied at least once during the growing season in the absence of a soil test; however, this is a poor substitute for a soil test.

Fertilize cool season grasses in September (1 pound of N / 1000 square feet) and again in November or December at 1 to 2 pounds of N / 1000 square feet when the grass is still green but not actively growing. This will encourage healthier plants and increase food reserves. An application of 1/2 to 1 pound of N / 1000 square feet applied between February 15 and March 15 is also suggested; however, do not apply excess fertilizer in late spring or summer for this will result in turf loss from increased summer stress and diseases.

IRRIGATION. Early morning is the preferred time to water. This will minimize potential disease problems, water loss through evaporation and poor water distribution due to wind. Water to a depth of 4 to 6 inches. Avoid watering the field again until signs of wilt (rolled leaves, bluish green color and foot printing) are apparent. Light, frequent waterings

promote shallow roots and diseases and results in a weakened turf. Avoid irrigating 2 to 3 days prior to heavy use to reduce compaction. Irrigate fields at least once every 4 weeks during drought periods to insure the plants do not die from drought.

SOIL CULTIVATION. Aerification (coring) alleviates compaction and is often necessary on athletic fields because of the heavy traffic they receive. Aerify in early spring using 3/4 to 1 inch tines THAT REMOVE SOIL CORES. Aerate the field lengthwise twice and crosswise once for each aereification. Allow plugs to dry, pulverize with mower or power rake and redistribute with a dragmat. Do not aerify cool season grasses in late spring or summer.

Vertical mowing for thatch removal may be necessary for Kentucky bluegrass fields but is seldom required and is not recommended for tall fescue. Consider dethatching if the thatch layer exceeds 1/2 inch. Set blades so they just touch the soil surface. Thatch removal should be done in the early spring and fall but never in late spring or summer.

Plan to rent, borrow or contract these services out if you do not have the appropriate equipment on hand.

PEST MANAGEMENT. Weeds are seldom a problem in healthy, dense vigorous turf; however, excessive wear and compaction from heavy traffic can result in weed encroachment. Annual grassy weeds are best controlled using preemergence herbicides applied in the spring. They should be applied by the time the dogwoods are in full bloom. Delay application by two weeks where only goosegrass is a problem. Selective herbicides such as 2 or 3 way combinations of 2,4-D; 2,4-DP; MCPP; and dicamba can be spring applied to control broadleaf weeds. Some broadleaf weeds are best controlled using products applied twice at one-half the labelled rate ten days apart.

Diseases and insects are seldom a problem on properly maintained athletic fields. If you suspect a disease or insect problem, make sure you correctly identify the pest before applying any pesticide. Contact your extension agent if you need assistance. (Oftentimes, a pest problem is an indication that changes in the turf management program currently employed are necessary.) If pesticides are warranted, select the most appropriate one, read and follow label directions and ensure the wise use of these pesticides. Reference manuals such as North Carolina Agricultural Chemicals Manual and the recently released Turfgrass Pest Management Manual can help pinpoint the cause and determine appropriate control measures.

RENOVATION. Tall fescue is a very wear tolerant grass but has poor recuperative potential and lacks the ability to fill in bare areas. Bluegrass on the other hand has the ability to fill in bare areas but not as quickly as other grasses such as bermudagrass. Areas exposed to serious compaction and wear should be reseeded in the fall and early spring using the following procedure:

1. Mow the area as low as possible without scalping the existing turf.
2. Remove the debris.
3. Fill in low areas using a soil mix that is comparable to that which is on the field.
4. Aerify in 4 to 6 directions, pulverize the cores and redistribute with a dragmat.
5. Seed bluegrass at 1.5 pounds / 1000 square feet and/or tall fescue at 7 pounds / 1000 square feet using certified seed of improved, adapted grasses.
6. Apply siduron at label rate to reduce annual grassy weed competition and treat the area as a new seeding.

OTHER CONSIDERATIONS

Even properly designed, constructed and maintained fields has a limit to the amount of use it can withstand. Reduce compaction and wear by keeping field use to a minimum when wet. Postpone play or use alternate sites, if feasible, for band practice and practice sessions. Move non-stationary goals if at all possible so that play will not be concentrated in given area. Consider widening existing fields so that this can be achieved. Set aside one field for team or tournament play if possible.

Consider adding a plant growth regulator to the paint used to mark the field. The paint can be used as the liquid requirement to dilute the retardant. This will help preserve the lines, reduce the number of times the lines must be painted and aid in finding the lines when repainting is necessary. THIS MUST BE DONE BY A QUALIFIED INDIVIDUAL SINCE THERE IS VERY LITTLE ROOM FOR ERROR.

ADJUSTMENTS IN TREE CARE PRACTICES

Tom Martin
Agricultural Extension Service

Arboriculture is the cultivation and care of woody plants, particularly trees. It has existed as an art and a science from the time man first recognized the value and beauty of trees.

Ideas about tree care formed over decades and centuries through trial and error, and by personal observation. These techniques and practices have been passed down from generation to generation. Most of the cause and effect relationship had to be assumed and was not based in sound, scientific research.

The lack of sound research in the areas of pruning, decay and wounding was probably due to the tedious, long term nature of such work. Few people were willing to take on these projects.

Fortunately for the tree care industry and the homeowner alike, several research scientist have met the challenge in recent years. A leader in this area is Dr. Alex Shigo, chief scientist with the U.S. Forest Service. His findings, based on hundreds of research papers and thousands of dissected trees, have slowly changed the way we look at tree care practices.

Shigo bases most of his recommendations on his expanded concept of tree decay which he labels CODIT. This is an acronym for Compartmentalyation of Decay In Trees. By knowing how a tree behaves after wounding allows you, the professional landscape manager, to help the tree make its own defense system operate at peak efficiency.

When a tree is wounded, whether it be by pruning, insect, disease, or physical abuse, three processes begin simultaneously:

1) Wound closure begins through the formation of callus tissue.

2) The process of compartmentalization is initiated, forming both chemical and anatomical barrier zones to wall off the damaged wood.

3) A gradual succession of microorganisms in injured and infected wood starting with those that discolor and progress to those which decay.

These basic concepts now allow us to look deep into a tree to see how it reacts to common tree care practices such as pruning, cavity filling, bark tracing and wound painting.

Tree roots were once thought to be largely buried deep below the ground. A closer look at tree roots by scientist in the last decade have proven to the contrary. By careful sampling techniques and tedious examination they have shown that 99% of the root system on most trees is in the top three feet of soil. This fact is particularly true in our area which is dominated by poorly aerated, heavy clay subsoils.

Careful examination of root systems has shown much of the root system in the form of fine feeder roots are concentrated on the upper eight to twelve inches of the soil. Feeder roots are the workhorses of the root system as they are the primary roots, involved in absorbtion of nutrients, and water, and the exchange of gases.

When these shallow roots are cut or damaged the tree suffers. Remove too many and the tree dies. Be very conscious of these shallow roots when tilling, grading, trenching, or simply applying fertilizers or herbicides.

When working with trees keep these basic concepts in mind. Your actions in a single afternoon can damage a tree that may take a century to replace.

COMPUTERS AND PARK MAINTENANCE

James H. Morgan
Director of Parks and Recreation
High Point, NC

About six years ago, I attended a recreation conference in Minneapolis, Minnesota, and became interested in computer applications. As soon as I returned to High Point, I purchased a home computer and signed up for several computer courses. I asked the City to supply me with a computer, and they said that a study was being proposed and we would have computers at every work station soon. Needless to say, I did not become a computer expert and, five years later, the City put one computer terminal CRT in the Parks and Recreation Department.

About the time I became interested in computers, we hired a new park superintendent and began preparing a maintenance plan. At the same time, the recession hit and growth in the city's tax base stopped. Our city laid off employees and cut back city services. We found the need for better records, particularly when it came to the cost of maintaining community park and recreation areas. We set up a manual of cost-tracking system and operated this system for six months. We were trying to determine the number of man-hours in various categories of maintenance work, such as building maintenance, multipurpose court maintenance, litter and trash pick-up, and grass mowing. When we were required to cut or economize on providing services, we would know fairly accurately what we were doing and where we were doing it so that the overall service of providing park maintenance would be least affected.

During the six months that we operated the system manually, we wrote a computer program for my home computer that would record the daily work record quickly and more accurately. We numbered our parks and identified 12 categories of maintenance work. This defined the parameters of our computer program.

We found that using a small home-type microcomputer that the data should be saved and stored on a monthly basis. We also found that by doing the recording on a manual basis for six months, we needed the capacity to store over a thousand work records each month.

This past July the City of High Point purchased and put into operation a prime, main frame computer. With our

Data Processing staff, we took the home computer program and put this program on our big computer. The main frame computer allows us to record and save each work entry as a separate record and allows us to use an abbreviation for the name of the park and the type of work we are performing. It also allows us to add a wider range of work categories. Maintenance activities are recorded for the following activities.

1. Public Buildings - all maintenance and repair.
2. Outdoor Courts - maintenance and repair of tennis, basketball, volleyball, or other outdoor courts.
3. Fencing - installation, maintenance, and repair.
4. Athletic Fields - preparation, lining, set-up.
5. Litter, Debris, Trash, Leaves - removal, collection, and disposal.
6. Turf Maintenance - all turf related activities.
7. Picnic Areas - Tables, Grills, Shelters, Benches - construction, maintenance, and repair.
8. Park Horticulture, Landscape, Woodlands, Trails, Paths - all maintenance of park areas.
9. Playgrounds - repairs, maintenance, new installation, renovation.
10. Park Roads, Parking, Bridges, Walks, Curbs - cleaning, repairs, edging, grading.
11. Special Assignments - Tents, Bleachers, Boxing Ring, Tables, Chairs, Special Events, Signs - set up and delivery of equipment and maintenance.
12. Utilities - repairs and maintenance of all outside utilities.

PARKS & RECREATION MAINTENANCE JOB ACCOUNTING

Division: Weather: Morning_____ Noon_____ Afternoon_____ Supervisor:

Date	Site/Location	Work Code	Time On Job	Work Order #	Description

Vehicle #: Starting Mileage: Ending Mileage:

ROADSIDE GROWTH RETARDANT RESEARCH UPDATE

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Growth retardants are compounds that slow plant growth by inhibiting cell division and/or elongation. Growth retardants can reduce the number of mowings, trimming requirements, and eliminate clipping of dangerous or difficult to mow areas. Weather and other practical limitations often prevent managers from mechanically mowing as frequently as is needed by the turf. While plant growth retardants often result in some degree of discoloration, mechanical mowing regimes often suffer from improper or delayed mowing which results in scalping, unsightly clipping accumulation, stand reduction and root loss.

Field roadside research projects using growth retardants during 1983 and 1984 have been conducted on bahiagrass and tall fescue turf. Tall fescue seedhead suppression under roadside conditions has been successfully attained following spring applications of MH (maleic hydrazide) at 2 to 4 lb ai/A, Embark (mefluidide) plus surfactant at 0.38 to 0.5 lb ai/A and Limit (amidochlor) at 2.5 lb ai/A. All three of these retardants are now commercially available for use on turf. Embark and MH are foliarly absorbed, while Limit is taken up throught the plant's root system. Short-stop (EPTC) at 6 to 8 lb ai/A, Escort (T6376) at 0.125 to 0.5 ounces ai/A and ACP1900 at 8 to 32 grams ai/A were also effective seedhead suppressants of tall fescue. Cutless (EL500) and Parlay (PP333) were not effective in reducing seedheads when applied alone, but either when applied in combination with Embark resulted in increased seedhead inhibition. Both of these experimental compounds provided better vegetative (shoot) growth inhibition than MH, Embark or Limit. Vegetative growth suppression of tall fescue increased with application rate for MH. Applications of MH on March 30, 1984 at either 2 or 4 lb ai/A resulted in better than 95% seedhead inhibition, while the shoot height of the 4 lb ai/A treated tall fescue was about 50% of that for the 2 lb ai/A treated turf.

The success of growth retardant applications for tall fescue seedhead suppression is dependent on the application date with respect to the plant's seedhead development. Fall applications of MH to tall fescue have been much more phytotoxic than spring treatments. Injury symptoms have included leaf tip burn and delayed spring green-up. While spring seedhead suppression following fall applications does occur, results have not exceeded 70% inhibition. February (eg. winter) application results have been similar to that described for the fall studies.

Seedhead suppression of tall fescue has been most successful for growth retardant applications after spring green-up of the turf, but prior to tall fescue reaching a height of 8 to 9 inches. Between these dates, the tall fescue seedhead has initiated seedhead development and attained a length of about 1 to 1.5 inches within the sheaths of the shoot. When the tall fescue seedhead reaches this length it is about 2 weeks from emergence out of the boot (ie. visible without dissection). Retardant applications beyond 2 weeks prior to seedhead emergence have resulted in decreasing levels of tall fescue infloresence suppression.

Turf shoot response following growth retardant treatment is influenced by nitrogen fertilization. Increased nitrogen fertilization near the time of retardant treatment will diminish turf discoloration, but may reduce the duration of growth suppression to less than the normal 6 to 8 week range. Fall nitrogen fertilization of tall fescue under roadside culture has improved turf quality following spring growth retardant applications without a reduction in seedhead suppression .

Studies have been conducted on the sensitivity of fall established tall fescue to spring applications of growth retardants. Retardants were applied on March 30, 1983 and 1984 to Ky-31 tall fescue that was established from seed the previous fall at a rate of 5 pounds of seed per 1000 ft^2. The turf was maintained under a mowed condition with a cutting height of 3 inches. The retardants applied were: Limit (amidochlor) at 2.5 lb ai/A, Cutless (flurprimidol or EL500) at 1 lb ai/A, MH (maleic hydrazide) at 4 lb ai/A, and Parlay (paclobutrazol) at 1 lb ai/A. Vegetative growth suppression persisted for 6 weeks after treatment. Phytotoxicity was most evident at 3 to 4 weeks after growth retardant application. The injury ranking of retardant treatments was as follows: Limit and Embark > Parlay > MH and Cutless > check. Maleic hydrazide was more phytotoxic during 1984 than 1983. All plots had nearly 100% cover by September of each year. Spring retardant applications to fall renovated or established tall fescue stands did not result in permanent turf injury.

Bahiagrass seedhead suppression trials have continued to be conducted at Pope Air Force Base in Fayetteville, NC. The 1984 study evaluated 16 retardant treatments applied on May 22. Growth retardant treatments on May 22 included: Oust at 0.5 oz ai/A, MH at 3 and 4 lb ai/A, Limit at 2.5 lb ai/A, MON4624 (combination of Limit and PP333) at 1.75 lb ai/A, ACP1900 at 4.5, 18 and 32 grams ai/A, Embark at 0.5 lb ai/A , Gylphosate (Roundup) at 0.19 or 0.25 lb ai/A with and without a follow-up treatment of 0.06 or 0.13 lb ai/A on July 9 and an untreated control. All treatments effectively suppressed bahiagrass seedheads with the exception of Embark, Limit and MON4624. Treatments were generally rate responsive with increased application rates resulting in improved seedhead suppression. The follow-up applications of glyphosate improved the duration of bahiagrass seedhead inhibition. In another trial, Oust induced chlorosis (yellowing) of bahiagrass was alleviated by foliar iron applications.

Plant growth retardant investigations planned for 1985 will seek to determine the effects of these compounds on weedy grasses such as broomsedge, foxtails, and Paspalum spp. Study treatments will also include herbicide and growth retardant combinations on both tall fescue and bahiagrass turf.

UTILIZING WILD FLOWERS IN THE LANDSCAPE

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Wild Flower use in the landscape is a relatively new alternative for low maintenance areas. Wild flower seed mixtures are now available that are specifically designed for different regions of the United States, to provide color and interest in low maintenance areas.

Establishing a wild flower field does need some special attention. For best results sow the seed on bare soil:

1. Rake the area to form grooves.
2. Use a drop spreader or cyclone spreader to apply the seed. On small sites seed may be hand broadcast.
3. Lightly rake over the area to ensure proper soil-seed contact.

On existing grass:

1. Use Roundup to eliminate any grass or seed cover which may compete with the wild flower seedlings.
2. Scarify the area with a rake or tine harrow to expose the soil surface.
3. Apply seed with a drop or cyclone spreader. A verticle groove seeder (Rodgers 548) may also be used. This scarifies and seeds at the same time.
4. Lightly rake over area or use tine harrow to ensure proper soil-seed contact.

The wild flower seed can also be hydroseeded onto slopes or hard to reach areas. For best results, do not mix the mulch in with the seed. For even coverage, first hydroseed the wild flowers onto the site and then spray the mulch over the seed.

Seeding dates are also important. Planting dates depend on site location. From Canada to Northern Florida and Central Texas the best results are obtained in early spring when the weather breaks. For late summer plantings, schedule seeding at least eight to nine weeks before first expected frost. If planted in late summer, some annuals will grow again the following season; others will produce seed in fall, which will germinate the following spring. Dormant seeding may be done when it is impossible to plant during optimum seeding times. Late fall seedings are undesirable.

Central and Southern Florida and Southern Texas: fall seeding is desirable. Summer seeding is not recommended. The mixture will flower during fall, winter and spring.

If there is no natural rainfall after seeding, adding moisture will help germination and early establishment along. If supplemental water is unavailable to the site, germination and establishment will occur, but at slower rates. Established wild flower plants will survive dry periods without water, but they will not flower as often.

Some species will bloom in six to eight weeks after planting. Others require various degrees of maturity before they can flower. There will be a succession of flowering during the growing season.

Adding a non-competitive grass to a wild flower mixture accomplishes a few things: 1) bulks up the mixture to make it easier to apply, 2) aids in soil stabilization without being competitive until the wild flowers get established, 3) tends to decrease annual weed competition. Bunch-type grasses such as sheep fescue or hard fescue are recommended as companion grasses. Aggressive grasses such as annual ryegrass or orchardgrass outcompete the wild flowers in the seedling state.

Since the seeding rates of wild flower mixtures are quite low (4-10 pounds per acre), sand or vermiculite can be added to the seed for extra bulk if the addition of grass seed is not desired for a particular site.

Once established, wild flower fields do not require a lot of maintenance. If the area is accessible and in close range to observers it would be advisable to mow the area once a year when the wild flowers are dormant. This will neaten the appearance of the area, aid in the dropping of the seed from the seedheads to the soil and will also prevent woody perennials from invading the site.

If tall aggressive annual weeds should invade the wild flower area, three mowings during the summer months, June, July and August at a height of 12-15" should help to decrease their competitiveness.

As far as longevity goes, if left unmown over a period of years, natural selection will take place with the invasion of woody shrubs and trees. Mowing will help to delay this occurence. Reseeding a site every few years is desirable to preserve the original balance of the mixture as natural selection will occur among the wild flowers themselves according to the conditions of each site.

Wild flowers are not the answer for every low maintenance area, however, it is a colorful solution worth considering for transition areas between mown lawn and wooded areas, out of play areas on golf courses, roadsides and industrial parks.

Grasses for Low Maintenance Areas

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With increasing restrictions being placed on fertilizer and water usage for recreational turf, the need for varieties requiring lower maintenance has become of interest to the entire turf industry. Varieties that perform well without supplemental irrigation, require low fertilization, resist crabgrass encroachment, are adaptable to sun or shade, have cold and heat tolerance, are easily established, and possess improved disease resistance have become a necessity. Fortunately, many of the proprietary cultivars do well under low maintenance.

A wide range of cool and warm season grasses, legumes and other plants of interest (Table 1) were established from seed during 1980 to evaluate their ability to adapt to low maintenance conditions of low maintenance during 1980 at seventeen locations in North Carolina (Table 2, Figure 1).

Soil samples were taken from each site and checked for pH, nutrient status, and particle size distribution (Table 3). The sites were tilled, with lime applied according to soil test along with 400 pounds per acre of a 10-20-20 fertilizer incorporated into the top four to six inches. All plots were hand-raked and rolled with a cultipacker before and after seeding. Straw mulch was applied at 60 lbs/1000 square feet and tacked with five gallons of RC250 asphalt.

Three plots (8 x 4 ft.) of each entry were established. Rain gauges and maximum-minimum thermometers were installed at each location and data recorded weekly. Performance of plant entries were recorded periodically for three years as percent of the total plot covered with desired vegetation.

Table 1. Entries established in adaptation trials by seed in spring 1980 at 17 locations throughout North Carolina

Species #	Common Name	Scientific Name	Seeding Rate* (lbs/acre)
101	Korean Lespedeza	Lespedeza stipulacea (Maxim)	18
102	Common Bermuda	Cynodon dactylon (L.) Pers.	66
103	Interstate Sericea Lespedeza	Lespedeza cuneata 'Interstate' (Dumont) G. Don	18
104	Kobe Striata	Lespedeza striata (Thunberg) H. + A.	18
105	Pensacola Bahiagrass	Paspalum notatum (Flugge)	74
106	Kentucky 31 Tall fescue	Festuca arundinacea (Schreb.)	107
107	Weeping Lovegrass	Eragrostis curvula (Schrader) Nees.	26
108	Carpetgrass	Axonopus affinis (Chase)	105
109	Hulled Sericea Lespedeza	Lespedeza cuneata	17
110	Centipedegrass	Eremochloa ophiuroides (Munro.) Hack.	13
111	Tioga Deertongue	Panicum clandestinum (L.)	13
112	Blackwell Switchgrass	Panicum virgatum (L.)	13
113	Kaw Big Bluestem	Andropogon gerardi (Vitman)	28
114	Aztec Maximillian Sunflower	Helianthus maximiliani 'Aztec" (Schrader)	3
115	Virgata Lespedeza 'Amaro'	Lespedeza cuneata 'Virgata' (Dumont) G. Don	40
116	NY-1145 Big Bluestem	Andropogon gerardi (Vitman)	1.5
117	Ambro Lespedeza	Lespedeza cuneata 'Ambro'	19
118	Lespedeza Thunbergii VA-70 Shrub	Lespedeza thunbergii	10
119	Lathco Flatpea	Lathyrus sylvestris	13
120	Alamo Switchgrass	Panicum virgatum (L.)	13
121	Coastal Panicgrass	Panicum amarulum (Hitchcock and Chase)	16
122	KC-802 Indiangrass	Sorghastrum nutans (L.) Little I. G.	6
123	Lespedeza Thunbergii AM-167	Lespedeza thunbergii	20
124	Ky-591 Indiangrass	Sorghastrum nutans (L.) Little I. G.	6
125	Crownvetch	Coronilla varia (L.)	11
126	Merion-Baron-Fylking Kentucky Bluegrasses	Poa pratensis (L.)	38
127	Kenblue Kentucky Bluegrass	Poa pratensis (L.)	90
128	Fortress Red Fescue	Festuca rubra (L.)	130
129	Birdsfoot Trefoil	Lotus corniculatus (L.)	6
130	Pennlawn Red Fescue	Festuca rubra (L.)	113
131	Chewings Red Fescue	Festuca rubra (L)	81
132	Common Perennial Rye	Lolium perenne (L.)	228
133	Hard Fescues	Festuca ovina var. duriuscula L. Koch	100
134	Caricea Sericea Lespedeza	Lespedeza cuneata 'Caricea' (Dumont) G. Don	20

* Seeding rates were adjusted for germination rate and purity

Table 2. Location and dates of establishment for the 17 plant adaptation trials evaluated in North Carolina during 1980 through 1984.

NCDOT Div. No.	County	Nearby city	Establishment date	Reestablishment date
1	Martin	Oak City	5/05/80	
1	Chowan	Edenton	3/09/81	
2	Carteret	Emerald Isle	3/10/80	3/10/81**
3	Brunswick	Wilmington	3/26/80	4/17/80***
4	Nash	Rocky Mount	5/06/80	
5	Granville	Creedmoor	5/14/80	10/24/80*
6	Bladen	Fayetteville	4/22/80	
7	Rockingham	Reidsville	5/15/80	10/07/80*
8	Moore	Southern Pines	4/25/80	
9	Davie	Mocksville	6/10/80	10/29/80*
10	Mecklenburg	Charlotte	5/27/80	10/28/80*
11	Yadkin	Hamptonville	6/17/80	10/16/80*
11	Wilkes	Deep Gap	6/18/80	10/09/80*
12	Catawba	Catawba	6/11/80	10/30/80*
13	Buncombe	Ashville	6/23/80	10/08/80*
14	Jackson	Whittier	7/01/80	10/15/80*
5	Wake	Raleigh	7/15/80	9/26/80*

* Cool season species only.
** Warm season species only.
*** Selected plots only.

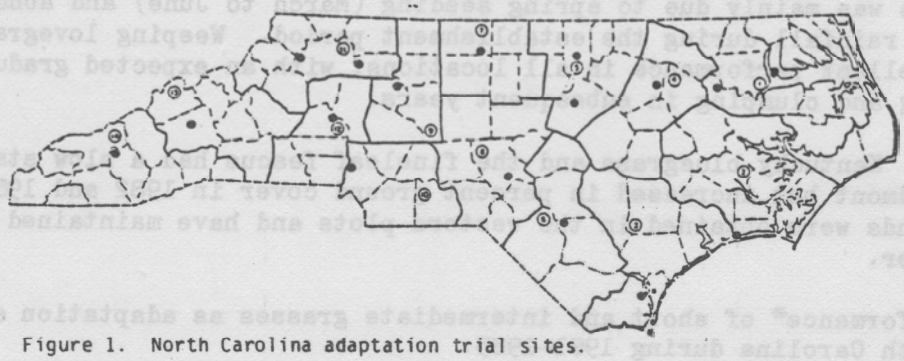

Figure 1. North Carolina adaptation trial sites.

Table 3. Soil conditions at each adaptation trial site prior to establishment in spring of 1980.

County	Division Number	Soil pH	Lime Applied Tons/A	% Clay	% Sand	% Silt	Textural Class
Martin	1	5.8	1.5	5.8	78.3	15.9	Loamy Sand
Chowan	1	6.5	0	2.1	95.2	2.7	Sand
Carteret	2	6.1	1.0*	1.7	97.2	1.2	Sand
Brunswick	3	7.5	0	6.3	91.8	1.9	Sand
Nash	4	5.2	1.0	30.8	65.3	3.8	Sandy Clay Loam
Granville	5	8.2	0	13.0	61.5	25.5	Sandy Loam
Bladen	6	6.0	0.5	3.0	83.9	13.2	Loamy Sand
Rockingham	7	7.1	0	8.1	61.0	30.9	Sandy Loam
Moore	8	5.5	1.0	5.0	89.3	5.7	Sand
Davie	9	5.7	1.5	31.2	40.9	27.9	Clay Loam
Mecklenberg	10	5.5	0.5	19.7	38.0	42.3	Loam
Wilkes	11	5.0	1.5	11.3	73.2	15.6	Sandy Loam
Yadkin	11	5.7	0.5	23.2	60.5	16.4	Sandy Clay Loam
Catawba	12	5.9	1.0	17.2	58.1	24.7	Sandy Loam
Buncombe	13	6.4	0.5	16.4	56.8	26.8	Sandy Loam
Jackson	14	5.5	1.5	7.1	65.1	27.8	Sandy Loam
Wake	5	7.0	0	33.1	51.0	15.9	Sandy Clay Loam

*An additional 0.5 tons/A was applied prior to re-establishment on April 18, 1981.

RESULTS

Table 4

The performance of Pensacola bahiagrass was better in the eastern part of North Carolina than the Piedmont as expected, primarily due to winterkill in some areas. In general, bahiagrass is not recommended north and west of a line from Raleigh to Charlotte. The cover of common bermudagrass plots was severely reduced from 1981, for under nonmowing conditions the thick residue of the first year's growth apparently restricted the growth that could be made the following years. The good performance of centipedegrass is interesting since this species is relatively low growing, low maintenance (low fertility and mowing requirements) and does best at a pH of 5.5. This species has done exceptionally well in western North Carolina.

Carpetgrass has very poor establishment and declined in cover after the first year. Kentucky 31 tall fescue made a very low percent cover in the eastern plots, with only fair cover in the Piedmont (30%). This was mainly due to spring seeding (March to June) and abnormally low rainfall during the establishment period. Weeping lovegrass had excellent performance in all locations, with an expected gradual thinning and clumping in subsequent years.

Kentucky bluegrass and the fineleaf fescue had a slow start in the Piedmont but increased in percent ground cover in 1982 and 1983. Better stands were obtained in the western plots and have maintained good cover.

Performance* of short and intermediate grasses as adaptation entries across North Carolina during 1981-1983.

Entry	Eastern			Piedmont			Western		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Bahiagrass, Pensacola	51	44	45	48	23	23	--+	--	--
Bermudagrass, Common	43	14	9	34	6	2	--	--	--
Centipedegrass	32	41	46	65	67	50	51	56	45
Carpetgrass	14	10	7	1	0	0	--	--	--
Tall Fescue, Ky 31**	11	6	7	31	31	29	49	52	65
Lovegrass, Weeping	83	74	74	94	71	56	87	74	63
Ky Bluegrass, Kenblue	--	--	--	36	56	47	61	73	76
Hard Fescue, Mix	--	--	--	45	63	60	64	81	77
Red Fescue, Pennlawn	--	--	--	41	47	46	55	70	65

* Mean September percent cover averaged across locations within a region.
** Spring established.
\+ Not established in this region.

Table 5

The performance of the tall grasses were quite good, with better cover obtained from east to west. The KC802 Indiangrass was better than the Ky591 selection in all locations, with little difference noted between the Alamo and Blackwell switchgrasses. The Kaw big bluestem was much better than the NY1145 selection, and generally improved in cover from east to west. The tall grasses should be utilized on unmowed sites to relieve the monotony of the vegetative cover with their attractive seed heads.

Performance* of tall grasses as adaptation trial entries across North Carolina during 1981-1983.

Entry	Eastern			Piedmont			Western		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Indiangrass, KC802	41	53	45	67	65	56	--+	--	--
Indiangrass, Ky591	19	34	36	47	57	49	--	--	--
Panicgrass, Coastal	27	39	35	46	46	56	--	--	--
Switchgrass, Alamo	41	52	51	72	84	79	--	--	--
Switchgrass, Blackwell	40	52	54	60	69	65	--	--	--
Big bluestem, Kaw	34	43	42	62	69	52	60	73	63
Big bluestem, NY1145	7	17	14	29	47	45	35	52	51

* Mean September percent cover averaged across locations within a region.
\+ Not established in this region.

Table 6

Most of the lespedezas had good initial cover, with improved performance from east to west. The perennial lespedezas maintained excellent cover with minor reductions in 1983. The annual lespedezas, Korean and Kobe had good initial stands in 1981, but failed to reseed in 1982.

Performance* of legumes and other species as adaptation entries across North Carolina during 1981-1983.

Entry	Eastern			Piedmont			Western		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Lespedeza, Ambro	33	48	43	67	78	67	89	82	64
" Interstate	43	63	48	87	90	66	87	90	78
" Kobe Striata	46	37	4	74	32	4	76	35	3
" Korean	50	31	2	48	24	1	53	25	6
" Sericea	50	65	53	90	88	81	85	88	76
" Virgata	44	58	51	77	82	69	81	86	64
" Caricea S.	--+	--	--	88	92	68	85	92	72
" Thum. AM167	27	40	37	67	77	72	72	84	85
" Thum. VA70	16	26	51	56	65	73	46	78	69

* Mean September percent cover averaged across locations within a region.
\+ Not established in this region.

Table 7

The Aztec Maxmillan sunflower is a perennial species and spreads with underground rhizomes. The plants have a typical sunflower bloom the size of the palm of a hand and gives a vivid touch of color from late August through October. Fair stands were obtained in the east with excellent cover in the Piedmont. The sunflower was not included in the western plots, but good results would be expected in the lower elevations. The Tioga deertongue had very poor establishment in the east and only fair cover in the Piedmont and western plots. This species is supposed to do well at the very low pH's. The Lathco flatpea also was very poor in the east and increased in cover in the Piedmont and western plots in 1982.

Birdsfoot trefoil and crownvetch did quite well in the Piedmont and western plots in 1981 and 1982, with a moderate decline in the western plots in 1983. Many of the crownvetch plots had excellent lateral spread and required frequent trimming to keep from smothering the adjacent plots.

Performance* of legumes and other species as adaptation entries across North Carolina during 1981-1983.

Entry	Eastern			Piedmont			Western		
	1981	1982	1983	1981	1982	1983	1981	1982	1983
Sunflower, Aztec M.	39	41	36	87	89	71	--	--	--
Deertongue, Tioga	3	2	0	30	37	33	33	41	41
Flatpea, Lathco	2	6	6	34	57	64	49	79	65
Trefoil, Birdsfoot	--	--	--	74	68	44	74	71	52
Crownvetch	6	31	30	54	52	56	72	78	44

* Mean September percent cover averaged across locations within a region.
\+ Not established in this region.

PLANT GROWTH REGULATORS ON GOLF COURSES

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Golf course management does depend upon the activity of plant growth regulators. These compounds are natural or synthetic organic substances that alter the growth and development of turfgrasses when applied at low dosages. Gibberellic acid is an example of a natural plant growth regulator that is a plant hormone. Bermudagrass fall dormancy and shoot color loss can be delayed following applications of gibberellic acid (25 grams/acre) shortly after exposure to chilling temperatures (less than 50 ^{o}F). Seed yield of tall fescue has been improved by applications of paclobutrazol, a synthetic plant growth regulator, to prevent the lodging of seedheads.

Growth retardants are a group of plant growth regulators that inhibit cell division and/or elongation. Retardants, when properly applied, can reduce turf mowing requirements, trimming need, and eliminate clipping of dangerous or difficult to mow areas. Maleic hydrazide (MH), mefluidide (Embark) and amidochlor (Limit) are commercially available growth retardants for use on turf. Maleic hydrazide has been used and evaluated for over 30 years, particularly on low maintenance turf (eg. rights-of-way). It is foliarly absorb and is typically applied at rates from 2 to 4 lb ai/A. Maleic hydrazide is an excellent seedhead suppressant of many grasses and often results in significant vegetative inhibition as well.

Mefluidide (Embark) was labelled for turf use in the mid-70's and is also foliarly absorbed. Mefluidide has been applied at rates from 0.125 to 0.5 lb ai/A (0.5 to 2 pints of formulation per acre) for seedhead inhibition. Vegetative growth suppression of mefluidide is equivalent to that observed for maleic hydrazide. Seedhead suppression of tall fescue by mefluidide has been best at rates of 0.38 to 0.5 lb ai/A (1.5 to 2 pints of formulation per acre). The use of a surfactant will enhance mefluidide retardant activity. Mefluidide has recently been labelled for Poa annua seedhead suppression using a rate of 0.125 lb ai/A (0.5 pints of formulation per acre). Mefluidide is **not** labelled for use on golf greens.

Amidochlor (Limit) was labelled in 1985 for use on cool season turf and will initially be available in the Northeastern United States. Unlike maleic hydrazide and mefluidide, amidochlor is primarily root absorbed and has a suggested application rate of 2.5 lb ai/A. Seedhead suppression of tall fescue following amidochlor treatment is equivalent to that of maleic hydrazide. This retardant is more active as a vegetative growth suppressant than maleic hydrazide and mefluidide and is somewhat less phytotoxic.

Experimental growth retardants include flurprimidol (Cutlass) and paclobutrazol (Parlay). These compounds are more effective vegetative growth inhibitors than the previous three commercial materials. Both of these retardants are root absorbed and are often applied at rates from 0.75 to 1.5 lb ai/A.

Several undesirable side effects often accompany or follow the application of growth retardants to turf. Growth retardants generally result in some level of discoloration at about 3 to 4 weeks after treatment. This discoloration is typically expressed as a leaf tip burn (browning) and/or enhanced senescence of older leaves. Phytotoxicity can be enhanced if the treated turf is under stress (water, traffic, etc.) at or shortly after application. Turf treated with growth retardants typically recovers from this discoloration and has color that exceeds untreated turf at 8 to 9 weeks after application. Stand density reductions have also been reported following retardant applications. However, this response is most often the result of treatment on stressed turf or multiple applications per year.

Root system losses have been noted, particularly in greenhouse and growth chamber studies. Such losses are not often observed under field conditions, particularly if the turf receives only one application per year. Disease incidence has been reported to increase following growth retardant treatment, particularly for Kentucky bluegrass . The nature of growth retardation results in a turf that can not rapidly recuperate following stress and damage. Applications of growth retardants near ornamentals and other nontarget plants should only be made with care after consulting the label for a given product. Most of these growth retardants have activity on one or more ornamentals as well as turf. Foliarly absorb growth retardants can be applied as directed sprays to turf and thereby avoid associated ornamentals. Care should be exercised when using root absorbed retardants near ornamentals since these compounds can be taken up from the soil by both the turf and nearby plants.

Plant growth retardants are often compared to mechanical mowing. However, it is not often remembered that improper mowing can result in scalping, unsightly clipping accumulation, stand reduction and root loss. Both retardant application and mechanical mowing require planning, equipment maintenance and adjustment, and alert operators. Growth retardant applications are perhaps more difficult than many other pesticide treatments since application rates are very low and skips very obvious.

Nitrogen fertilization can influence turf response following growth retardant treatment. Increased nitrogen fertilization will diminish turf discoloration, but may reduce the length of growth suppression to less than the normal 6 to 8 week range.

Growth retardants offer immediate use as trimming agents in and around golf course grounds. Treatment of fence rows, foundations, mowing obstacles (eg. benches, posts), slopes and other difficult to mow areas can result in significant savings in trimming time and cost. Growth retardant trimming can result in a more aesthetic turf than that by soil sterilants and nonselective herbicides. Growth retardant trimming can reduce soil erosion compared to soil sterilants and nonselective herbicides. Broadcast application for roughs and other low maintenance turf might also be appropriate for certain golf course maintenance programs.

REASONS FOR AERIFYING

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The basis reason for aerifying is to be sure there is sufficient oxygen in the soil in which your grass is growing to allow the grass roots to carry on respiration properly. Unless oxygen is available, the plant roots cannot live. Why not? Actually, respiration, properly defined, is the breakdown of chemical compounds to release the chemical energy and allow its use in carrying out life's processes. This process requires oxygen. Without oxygen you cannot sustain life processes (growth, etc.) or even life. That's why grass roots die prematurely in compacted soil and are not replaced. That's why they shorten under stress.

Another reason for aerifying is to reduce compaction so grass roots can penetrate and occupy a greater soil area. If roots cannot physically penetrate portions of the soil, the area from which roots can absorb air, water, nutrients, etc. is severely limited. Also, under such adverse conditons those essentials of life (air, water, nutrients) are most likely not available in sufficient amounts and/or proper concentrations.

Further, some modification of a soil can be accomplished by aerifying, removing the original soil cores, then filling the aerifyer holes with a soil, or other material which will increase the amount of large pores in soil. Remember, the objective is to increase the oxygen content of the soil and allow the soil to remain uncompacted under traffic. Modification is a slow process. Noticeable results may require years; however, it may be the only alternative for some courses.

Also, aerifying can increase the resilience of a green. Aerifier holes that are left open or filled with a more porous material will fill with grass roots. Both the removal of compacted soil cores and grass roots filling the voids will increase resilience. But, even that will not excuse a poor golf shot.

Proper aerification can be accomplished only with a machine that removes soil cores. Hollow tines or augers are the only tools presently available that do the job as it should be done. Spikers do not do the job properly. They can be used to break a crust on the soil surface, but deeper spiking is usually only temporary and mostly ineffective. Slicing, generally, falls in the same category as spiking.

Aerification should be done during periods when the grass grows best. This means spring and fall for bentgrass and summer for bermudagrass. Whether aerification is done, or how many times to do it, depends on the degree of soil compaction, the depth of grass rooting, whether or not the soil needs modifying, the resilience of the green, the response of the grass to proper management, the condition and quality desired on a putting surface, as well as other factors. Most greens require more than they get. I have never seen a set of greens that have been aerified too much. All such operations have to be a compromise between what is best for the grass and what the golfers will accept. The two are not necessarily the same.

In conclusion, aerification is essential. All greens are not constructed perfectly. Until such construction is perfect and until playing on greens is beneficial rather than harmful, aerifiers must and will be used.

TOUR OF GOLF COURSES IN SCOTLAND

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In August of 1984, I had the privilege of joining the UNC Golf Team for a week-long tour of golf courses in Scotland. In six days we played golf at the following courses:

1. Western Gales
2. Turnberry - Arnran and Ailsa Courses
3. Carnoustie
4. Glenn Eagles - Kings Course
5. Murfield
6. St. Andrews - Old Course
7. Prestwick

While each course had its own individual character and beauty, the one common link between all of the courses were their obvious low level of maintenance. As an American golf course superintendent, I found this to be an eye-opening experience. This lack of intense maintenance, as we in the U.S. demand and expect on our golf courses, did nothing to detract from our play. In fact, in my opinion it challenges the golfer to learn how to play an assortment of shots. It also puts the element of luck and the "rub of the green" back into the game.

Another interesting aspect of Scottish golf courses compared to American courses is what is considered fair. Most American golf holes are laid out so that the fairway, any hazards, bunkers, and except for extreme doglegs, the greens are visible from the tee. While Scottish courses consist of many holes where without the aid of a caddy one would have no idea which direction to hit the tee shot. Pot bunkers in the middle of the driving area, deep bunkers where the only possible shot is to play sideways or backwards, and blind shots over sand dunes to greens are commonplace.

Having been on this trip, I would highly recommend that all people who have a strong interest in golf, or golf courses, should make every effort to someday travel to Scotland, the birthplace of golf. Seeing the first golf courses and how their tradition has been upheld can give us a new perspective on the game and how it should be played.

SEASONAL COLOR FOR GOLF COURSES

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Many novice landscapers and gardeners plant flowering shrubs in an area just to help "make the place pretty." After planting flowering trees and shrubs in several areas one soon might realize that the one thing missing is unity or composition. Plants in the landscape are generally intended to be functional units in the design: screening, focal point, direct traffic and pedestrian circulation, soften architectural lines. The important point to remember is that plants are not used "just to make an area pretty." Plants are just one component in the overall system that helps contribute to a successful landscape, one which is functional and one which is aesthetically pleasing.

Color is just one design quality. The others to remember are line, form and texture. So don't make the typical mistake of exaggerating the importance of color and create a landscape solely on this one design quality.

When designing an area, one should emphasize seasonal interest and color. The following is a partial list of flowering trees and shrubs for North Carolina and the approximate flowering period:

Common Name	Scientific Name	Time Period When Flowering Begins*	Color of Flowers **
Japanese Camellia	Camellia japonica	1/15 - 4/15	rd, pk, wh
Flowering Quince	Chaenomeles spp.	2/1 - 2/25	rd, pk, wh
Forsythia	Forsythia spp.	1/25 - 3/10	yellow
Witch Hazel	Hamamelis spp.	1/10-3/30	yellow
Winter Jasmine	Jasminum nudiflorum	1/1 - 3/10	yellow
Star Magnolia	Magnolia stellata	2/1 - 3/5	wh
Leather Leaf Mahonia	Mahonia bealei	2/10 - 3/10	yellow
Wintergreen Barberry	Berberis julianae	3/10 - 4/5	yellow
Redbud (Eastern or Chinese)	Cercis ssp.	3/1 - 4/7	pk, wh
Flowering Dogwood	Cornus florida	4/1 - 4/30	wh, pk
Saucer Magnolia	Magnolia soulangiana	3/5 - 4/5	pk
Flowering Cherries	Prunus spp.	3/10 - 4/20	pk, wh
Callery Pear (Bradford)	Pyrus calleryana	3/5 - 4/1	wh
Thunberg Spiraea	Spiraea thumbergii	3/10 - 4/10	wh
Wisteria	Wisteria spp.	3/15 - 4/10	lavender
Other barberry	Berberis spp.	4/10 - 5/10	wh, yellow
Beautyberry	Callicarpa spp.	4/10 - 5/10	yellow
Cotoneaster	Cotoneaster spp.	4/15 - 5/20	pk, wh
Washington Hawthorne	Crataegus phaenopyrum	4/10 -5/10	pk
Mountain Laurel	Kalmia latifolia	4/15 - 5/10	pk
Crabapples	Malus spp.	4/1 - 5/10	wh, rd, pk, purple
Vibernum	Vibernum spp.	4/15 - 5/1	wh
Chinese Photina	Photinia serrulata	4/1 - 5/5	wh

Common Name	Scientific Name	Time Period When Flowering Begins*	Color of Flowers**
Pyracantha	Pyracantha spp.	4/15 - 5/20	wh
Vanhoutte Spiraea	Spiraea X vanhouttei	4/1 - 5/10	wh
Catawba Rhododendron and Azaleas	Rhododendron spp.	4/1 - 5/15	varied
Hybrid Roses	Rosa spp.	4/1 - summer	varied
Common Lilac	Syringa vulgaris	4/5 - 5/10	lilac, wh
Periwinkle	Vinca spp.	3/20 - on	lilac, wh
Weigela	Weigela spp.	4/5 - 5/10	rd, pk
Glossy Abelia	Abelia grandiflora	5/20 - through summer	pk
Catalpa	Catalpa spp.	5/5 - 6/1	wh
Clematis	Clematis spp.	5/1 - 6/1	varied
Flowering Jasmine	Jasminum floridum	4/28 - 5/11	yellow
Southern Magnolia	Magnolia grandiflora	5/1 - 6/1	cream
Japanese Pagoda Tree	Sophora japonica	6/1 - 7/1	wh
Cape Jasmine	Gardenia jasminoides	6/1 - 7/1	wh
Althea (Rose of Sharon)	Hibiscus syriacus	6/10 - 7/1	varied
Golden Rain Tree	Koelreuteria paniculata	6/1 - 8/5	yellow
Crape Myrtle	Lagerstroemia indica	6/15 - through summer	varied
Sasanqua Camellia	Camellia sasanqua	11/1 - 12/15	varied
Osmanthus	Osmanthus spp.	9/15 - 10/30	wh

Note:
* The dates given represent a period of time when the plant begins flowering. The dates only represent an estimation of flowering time. Actual flowering time may differ due to local climactic variations and specific spring weather for a specific year.

**rd = red, pk = pink, wh = white

When landscaping in a country club or golf course area try to maximize the visibility of the planting. Direct emphasis near the club house, pro shop, parking lots, and dining area. On the course, create interesting views from the tees and greens. Be certain all landscape beds are located where they should not "come into play," and a high priority for most landscaping is that the design and plant selection reflect a minimum amount of maintenance.

Pythium Diseases on Golf Greens

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Several different Pythium species cause serious diseases on golf greens in North Carolina. The common names of these diseases are often referred to as Pythium blight, cottony blight, grease spot, root rot, snow blight, and seedling blight. Bentgrass and ryegrass are especially suspectible to these diseases. Pythium species are often associated with the roots of bermudagrass, but are not known to cause severe damage on this grass in North Carolina. These fungi are present in soil on most golf greens and survive as saprophytes in organic matter or as parasites in roots. Wet conditions during cold or hot weather are favorable for growth of the different species, and diseases caused by this group of fungi can develop at different times of the year.

Pythium blight develops rapidly during hot-wet weather when excessive soil moisture is present. Circular spots 1 to 3 inches in diameter suddenly appear during hot, humid weather. The spots may continue to enlarge or the disease can develop in long streaks where spores are spread by water or mowers. Rapid spread often occurs in drainage patterns and in the wettest areas of greens. Diseased leaves appear water soaked (very dark green) and die quickly. The dying leaves feel slimy when rubbed, hence the name grease spot. Under very humid conditions, fluffy white to gray mycelium may cover the spots. This is the cottony blight stage. Cottony blight is not seen often on short cut grasses on greens. The short, fuzzy white mycelium that often occurs on dollar spot patches is often confused with cottony blight. Dollar spot usually develops over several days to a maximum size of about 2 inches in diameter which differentiates that disease from Pythium blight or cottony blight. Lesions on leaves caused by Pythium species do not have dark margins between healthy and dead tissue like dollar spot lesions. Pythium blight can spread very rapidly. It is very important to accurately identify the disease in the early stage. If proper fungicides are not applied, nearly all the bentgrass or ryegrass on a green can be killed in one to two days.

Pythium root rot has been associated with the decline of bentgrass on golf greens during the summer in recent years. The grass becomes thin, usually beginning on the

wettest greens or in poorly drained areas on a green. Once the grass begins declining from Pythium root rot, it may continue to decline and recover very slowly even after effective fungicides are applied. Apparently the fungus damages most of the root system and new roots grow very slowly during hot weather. The disease even occurs on golf greens that were constructed with large amounts of sand. Excessive drying of the soil may even encourage the development of this disease. Therefore, the maintenance of soil moisture at proper levels may help prevent damage from Pythium root rot.

Some Pythium species can cause disease in cold weather. Snow blight can develop under snow, especially if high rates of nitrogen fertilizer have been applied and soil drainage is poor. This disease can develop in cold wet weather without snow cover. Symptoms may be similar to pink snow mold that is caused by Fusarium nivale.

Several Pythium species can cause severe seedling blights. Large areas, or a large percentage of seedlings, can be killed during hot-wet weather. One of the main reasons to plant cool-season turfgrasses in the fall when temperatures are cooler is to avoid conditions that favor the development of these seedling blights.

The identification of diseases caused but Pythium species is often difficult. Many different species occur naturally in soil and can survive as saprophytes in organic matter or as parasites in roots. When favorable conditions for disease occur, these fungi can grow rapidly and cause serious damage. Large numbers of spores that can swim in water, called zoospores, are produced and spread rapidly to nearby plants or in moving water. The rapid growth of the fungi and the movement of the zoospores accounts for the rapid spread of Pythium diseases. Microscopic identification of the fungi in plant tissue can be difficult. Isolation and identification of the fungi can take several days in the laboratory. Extensive damage may occur on greens by that time. Therefore, effective fungicides are often applied, and should be applied, before an identification of the fungus is made if the weather is hot and wet and Pythium blight is suspected.

Cultural practices can be used to help prevent and control Pythium diseases. Construction of golf greens to insure good surface and internal drainage is recommended. Since the fungi grow best in soils with excessive moisture and the plants are more susceptible under such conditions,

the removal of excessive water is very important. Over-watering and watering in the late afternoon should be avoided. High temperatures and humidity that favor disease development are often associated with poor air drainage. Avoid planting trees and shrubs, or remove nearby plants that shade or prevent wind from blowing across greens. Also, avoid locating greens in low areas that are surrounded by trees whenever possible.

Aerification to improve soil drainage and to allow more air into the soil will help prevent Pythium diseases and help the plants recover once disease has developed. Even aerification in mid-summer has been needed to help overcome and recover from Pythium root rot.

Raising the height of cut in hot weather will help produce a more healthy turf. Avoid mowing as much as possible when the soil is very wet to prevent spread of the disease.

Proper fertilization is very important in helping avoid and control diseases caused by Pythium species. Bentgrass or ryegrasses are more susceptible to Pythium species when fertilized with high rates of nitrogen. Keep nitrogen levels low during the summer but provide adequate amounts of other nutrients.

Seedling diseases will be less severe if seeds are planted in the fall and if fungicide-treated seeds are used. Most of the improved ryegrass varieties are treated with fungicides that will control Pythium species before sale. Subdue or Koban are used most often to treat seeds. Bentgrass seeds are not usually treated. Fungicides can be applied shortly before or just after seeding to help control seedling blight.

Fungicides are usually needed to control Pythium diseases on bentgrass golf greens especially during the summer. The following chemicals can be used to control Pythium species: chloroneb (Tersan SP), etridiazole (Koban), metalaxyl (Subdue, Proturf Pythium Control), and propamocarb (Banol). Preventative applications of fungicides before disease appears when conditions are favorable for disease to develop is needed for good control of Pythium diseases. Curative treatments after disease is present with higher rates of fungicides often does not give good control. Also, curative control is more difficult during wet weather if a good preventative control program has not been used. Several of the fungicides that are effective against Pythium species

should be used in a control program. Avoid using the same fungicide time after time to help prevent the possible selection of resistant strains of the fungi. Most of these fungicides are effective for controlling Pythium blight. Koban and Subdue have given the best control of seedling blights. None of these fungicides have given very good control of Pythium root rot once the grass has begun thinning. A good preventative program is best to help prevent this disease.

In summary, several different diseases caused by Pythium species occur at different times of the year on golf greens in North Carolina. Good management practices will help control these diseases. Fungicides are usually needed at some time of the year. You should be able to identify Pythium disease rapidly and accurately so that effective fungicides can be selected and applied quickly to prevent serious damage. Assistance is available from the North Carolina Agricultural Extension Service to help you identify these diseases.

PLANTING TECHNIQUES FOR TREES AND SHRUBS IN URBAN AREAS

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Trees and shrubs planted along city streets and in parking lots often experience a slower growth rate and a higher mortality rate than the same plant species in more open areas. Several basic problems are generally associated with the loss of plants in urban areas. A site analysis often reveals those conditions as follows:

- The soils are extremely disturbed and normal water movement is restricted.
- Due to man-made hydrologic changes, the sites are either too wet or too dry.
- There is too little room for roots to grow.
- The plants chosen for the area were not adapted to the site conditions and/or not planted correctly in the early states of development.

To design an area using trees and shrubs which will grow and mature, and generally contribute to the landscape, the following planting recommendations should be considered:

1) In extremely compacted soils, plants should not be planted until the entire planting area is deep-tilled or rotovated. Plant the tree or shrub in a "raised" manner using native soil as backfill. Since the drainage could be poor, drainage tiles might be necessary. These soils are generally considered infertile and generous amounts of lime and phosphorous are required.

2) In areas with expandable clay subsoils, a perched water table for extended periods will exist. Plant choice is critical and the plants should be planted in a raised bed over drainage tile. A coarse, sandy loam topsoil should be used as fill over the tile and as a planting media for the trees and shrubs.

3) Areas with limited root zone area or overhead clearance limitations because of below or above utility restrictions should be carefully designed. Think about the mature size of the plants. The small to medium sized trees (30' or less) are generally recommended as they have traditionally caused the fewest problems. Be certain to locate parking lot or street trees back away from the curb where contact with vehicles will not cause damage. Planting should be delayed until all construction and paving is complete. The soils should be deep-tilled and properly limed before planting. The plants should be placed on the bottom of the tree pits and not on backfill. Remember: Plant selection is critical for a successful project in these restricted areas.

TURF-TYPE TALL FESCUES

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Tall fescue is one of the most important grasses in the United States. Although originally introduced from Europe in the early 1800's, tall fescue is now found in 42 of the 50 states. Its adaptation to a wide variety of soil and climatic conditions has led to its use in soil stabilization, forage and turf. It is only within the last 20 years that tall fescue has received attention and acceptance as a groomed turfgrass although varieties such as Alta and Kentucky 31 were developed and released in the early 1940's.

Tall fescues have gained rapid acceptance for forage and soil stabilization. Its tough, coarse roots have the ability to penetrate subsoil and contribute to the sod-forming, drought avoidance, and tolerance to some soil insects. These same characteristics have been of value in turfgrass application where many other cool-season turfgrasses would not persist. Although best growth of tall fescue occurs under relatively cool, moist growing conditions, it is the only cool-season turfgrass that will persist well through the hot summers in many parts of the Southern and Southwestern United States.

Tall fescue, as a turfgrass, finds its greatest usefulness in the transition zone which separates the northern cool-season and the southern warm-season grass zones. More recently, use of tall fescue, especially the new turf-type tall fescue, has increased substantially in many mid-south areas such as north central Alabama, Georgia, central Arkansas, Oklahoma, northern Texas, higher elevations of Arizona and New Mexico, as well as throughout southwestern California. One key characteristic that has led to more extensive use of tall fescue in the mid-south is its winter color. Unlike warm-season grasses, tall fescue does not go through a period of winter dormancy in this region, thus it exhibits a year-round green color.

Tall fescue has received much attention from plant breeders over the last 15 years as substantial improvements have been made in the turfgrass qualities: color, density, reduced blade width, disease resistance, and tolerance to lower mowing. The improved varieties such as Olympic, Falcon, Rebel, Galway, Monaco, and

Clemfine show significant improvements over the much coarser types such as K-31 and Alta.

As the improved turf-type varieties have become available, utilization of these varieties has increased in the mid-south. In areas of the mid-south where year-round color is desired, tall fescues have adapted well to a wide range of soil types, surviving in pH ranges from 4.7 to 8.5. They have also exhibited above average tolerance to salinity and compacted soils. In shade, turf-type tall fescues have become an excellent substitute for St. Augustine. Under shaded conditions, turf-type tall fescues exhibit considerably finer texture than in full sun and significantly improved shade tolerance as compared to Kentucky 31.

The turf-type tall fescues show significant improvement in disease resistance to Helminthosporium blight (net blotch) and Rhizoctonia brown patch as compared to Fawn, Alta, and Kentucky 31 increasing their usefulness and persistence in turf situations. Helminthosporium blight is most active during cool, moist weather. Brown patch is most serious during moderately hot, humid weather.

Turf-type tall fescues are noted for their high seedling vigor with emergence occurring at 6 to 10 days at 60 F. Since tall fescue has the largest seed of the turfgrasses and is a bunch grass having few, if any, rhizomes, it is necessary to use a seeding rate of 6 to 10 lbs. per 1,000 sq. ft. to provide a uniform, dense stand.

Cultural practices in the mid-south and southwest are somewhat different than those of most warm-season grasses. It is most desirable to apply 2/3 of the total year's nitrogen requirement in the fall and early winter and the remainder in early spring. This will allow the tall fescue plant to develop carbohydrate reserves during the cool season. By not feeding the turf in late spring and summer we reduce the succulent, soft summer growth that is more subject to disease. This schedule of feeding will also encourage more extensive development of the plant's root system.

Nitrogen programs in the range of 4 lbs. of Nitrogen per 1,000 sq. ft. per season is suggested, balanced with sufficient phosphorous and potash. Maintaining high potash levels in the plant will assist in reducing drought stress.

Mowing height can be somewhat lower (1.75 to 2") in the September through April period than in the summer when

the plants will be less subject to stress and moisture loss if maintained at 2-1/2 to 3".

Supplemental irrigation will be necessary in most mid-south and southwestern areas of limited summer rainfall. Timing should be such as to encourage maintaining deep rooting. Frequent, light applications are less desirable, although very light applications (syringing) may be necessary to reduce wilting during periods of intense heat stress.

Removal of grass clippings on turf-type tall fescues, unless required for aesthetic reasons, is not encouraged as it has been shown that thatch accumulation in this species is not a problem. Allowing the clippings to decompose at the soil surface will return nutrients to the plants.

Sod producers, hydroseeders, professional lawn care companies, and landscape contractors have found a ready market for these darker green, improved turf-type tall fescue varieties. Demand has, over the past 5 years, far outdistanced the supply of seed. As a result, in some instances less than adequate quality seed has found its way into the marketplace. If you have interest in trying these varieties, you are encouraged to insist on certified (blue tag) seed to avoid the possibility of varietal substitution and contamination with other crop seed. The following paragraph by Dr. Reed Funk, one of the leading turf-type tall fescue plant breeders, is an excellent review of the seed quality subject.

"Use of quality seed of an adapted variety is basic to the production of quality turf. Varietal substitution, poor germination, and objectional weed or other crop seed can cause serious problems. Most seed of Kentucky 31 tall fescue is grown as a by-product of pasture production in areas of southwest Missouri. Much of this seed contains orchardgrass and other contaminants that may be objectional in a permanent turf. Most of the seed of the newer turf-type tall fescues is produced in Oregon by professional seed growers. Much of this seed is of excellent quality and free of undesirable contaminants. Unfortunately, some of this seed has variable amounts of annual or perennial ryegrass as a contaminant. Annual ryegrass seedlings are much more robust and lighter in color and can easily be recognized in a new seeding. Their presence will reduce quality and increase the requirment for frequent mowing during the period of establishment. Excessive amounts of annual ryegrass could cause excessive competition to the smaller tall fescue

seedlings and retard the establishment of a good, permanent turf.

Turf-type tall fescues provide turf managers with one more alternative. When an opportunity for use arises give them a try -- they're here to stay.

Table 1. Tiller density and leaf width measurements of Tall Fescue varieties grown in closely mowed turf trials at Adelphia, New Jersey.

Variety	No. Tillers per sq. ft. Nov. 1979	Leaf Width mm Nov. 1979
Olympic	1852	2.7
Rebel	1801	2.7
Falcon	1750	2.6
Galway	1378	3.1
Monaco	1297	2.5
Clemfine	1247	3.0
Kentucky 31	1156	3.4
Fawn	1102	3.7
Kenmont	1086	3.6
Goar	1062	3.5
Kenhy	1013	3.5
Kenwell	945	3.6
Alta	902	3.8
LSD at 5%	453	0.6

Test seeded September 1978 and mowed at ¾-inch.

Leadership Styles

Dr. Teck Penland
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This session concentrated on the importance of appropriate leadership styles. The model utilized for this session was taken from a contingency leadership approach developed by Paul Hersey and Kenneth H. Blanchard. The model departs from many traditional models in that it states that there is "no one best leadership style." This model strongly emphasizes the importance of matching the appropriate leadership style with the maturity level of the individual you are attempting to lead.

Dr. Penland clarified "maturity level" as meaning the motivational level and the expertise level of the individual for the task you are expecting them to complete. A scale of one to four was utilized in order to illustrate typical maturity patterns.

Dr. Penland's message was clearly that one should match their leadership style to the situation, individual maturity level, and the task expectation. Four leadership styles were explained and demonstrated ranging from autocratic to delegating. Participants were encouraged to consider the combinations of leadership styles and maturity levels that exist within their own businesses.

The expected outcomes of this workshop were that participants would gain some awareness of their own style of leading people and recognize the importance of understanding the maturity levels of others.

TALL FESCUE SOD PRODUCTION USING NETTING

Mr. Bill Riggan *
United Turf Inc.
Louisburg, N. C.

A demand for tall fescue sod has developed in the transition zone in piedmont North Carolina for use on commerical and residential sites. Unlike sod forming grasses such as Kentucky bluegrass and bermudagrass, tall fescue producues few if any rhizomes for good sod strength. Because of additional strength to harvested sod and earlier harvest, netting is now being used in the production of tall fescue sod. A description of the use of netting in the production of sod at United Turf is given below.

United Turf planted tall fescue with netting for sod production for the first time in the fall of 1981. A number of netting products have been introduced since 1972, but netting was first introduced to growers at the 1978 American Sod Producers Association convention in Spokane, Washington. A netting with a small mesh was selected by United Turf that costs about $210 per acre.

The production and delivery of good sod requires a series of steps in the following order: (1) selection of improved, adaptd cultivars and good quality seeds, (2) proper soil preparation, (3) proper installation of netting and seeding, (4) maintenance of the turf for rapid growth of good quality sod, (5) harvesting the sod properly, (6) and handling it properly during transportation and before installation. A good irrigation system was installed by United Turf preceeding the planting of any sod. The application of water when needed following seeding, during the growing season and before harvest is very important in the production of good quality sod.

Selection of varieties and seed suppliers begins in January or February since seeds of some of the better varieties are in limited supply. The new turf-type tall fescues with better texture, color and more disease resistance that are adapted to the area have been selected. A mixture of a new turf-type tall fescue and a bluegrass variety in a 90 to 10 mix by weight has been used by United Turf. This mixture results in a 50/50 seed count of the two grasses. Sod from this mixture is well adapted to the piedmont and has a finer texture than tall fescue alone. Certified seeds are used to insure good quality seeds with good germination and a minimum of crop and weed seeds.

*Now with Boyco

Soil preparation begins in the spring with soil sampling for fertilzer and lime recommendations. Any old sod or weeds in the field are killed with herbicides and lime is applied before tilling during the summer. The land is tilled again, smoothed with a harrow and firmed with a cultipacker just before seeding. The soil will need to be reworked if it rains before the netting is installed and the seeds planted.

Seeding and netting installation begins about the first of September. The seeds can be planted by broadcasting or in rows and the netting rolled on top. However, United Turf purchased a machine that incorporates netting installation and seeding into one operation. The machine has V-blades to smooth and lift some soil into a box on the machine. Seeds are mixed with the soil and the netting layed on the soil surface. A thin layer of the soil and seed mixture is then deposited in a smooth layer over the netting in one operation. Seeds are planted at a rate of 350 pounds per acre or about 8 pounds per 1000 square feet. Some problems with the netting result if the soil surface is not smooth and if water washes the soil off the netting. However, the advantages of the netting outweigh the disadvantages.

A starter fertilizer supplying one pound of phosphorus per 1000 square feet is applied at the time of seeding. Approximately one half inch of water is applied immediately after seeding to facilitate rapid germination. Irrigation is applied frequently until seedlings are well established. The turf is mowed at 2 1/4 inches when plants are about 3 inches tall and is mowed at that height regularly. When the turf is mature enough, a roller is used to smooth the surface to insure even mowing and harvesting. The turf is sprayed with herbicides to control winter annual weeds as needed. Fertilizer is applied at the rate of one pound of nitrogen per 1000 square feet as needed with a total of 3 to 4 pounds of nitrogen being applied per season. There are a lot of fertilizers that can be used, but one with an IBDU source of nitrogen has given good results.

The sod is harvested in strips (18 inches wide by 72 inches long) and is rolled. The netting does not cause a problem in harvesting. The sod is cut with about 3/4 inch of roots and soil attached with the netting included in the sod.

The netting adds strength to the sod so that it can be harvested earlier, in about six months, and it does not break apart during harvesting, transportation or installation. The sod with netting is easy to handle and results in less waste than without it. In summary, netting provides many advantages in the production of sod with grasses such as tall fescue that do not form a strong sod.

Turfgrass Cultivars and Availability

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North Carolina State University
Raleigh, North Carolina

Many of the new turfgrass cultivars being developed are in the NCSU turf center testing program. The availability of the varieties and an estimate of their pricing is from the American Sod Producers, Association, July/August 1984.

TURF-TYPE TALL FESCUES

In the last few years an intensive effort has been made by plant breeders to develop improved turf-type tall fescue varieties with finer leaf texture, improved disease tolerance, better heat and drought tolerance, and enhanced persistence under shorter cutting heights compared to Kentucky 31 tall fescue.

Cultural procedures. A turf-type tall fescue trial was initiated in 1981 with many of the available commercial cultivars. The seedings rate was 5 pounds per 1000 square feet and clipping height of 2 inches. Two of the trial entries had one pound Kentucky bluegrass added. Plots were fertilized with a 12-4-8 source at a rate of two pounds N per year as split applications of one pound each on September and February.

Results. The turf quality performance data for 1982, 1983, and 1984 is presented in Table 1. Adventure, Rebel, Falcon, and Mustang tall fescues were the top rated cultivars in 1984. The addition of Kentucky bluegrass improved the rating of Ky 31 tall fescue.

Table 1

Turf-type fescue quality ratings for 1982-1984, Raleigh, N.C.

Cultivar	1982	1983	1984
Adventure	6.9	8.0	7.7
Rebel	7.5	7.5	7.6
Falcon	7.1	7.4	7.2
Ky 31 + Glade + Kenblue	7.3	7.4	7.2
Galway (K5-27) --NK	6.6	7.0	6.8
Ky 31 - Kenblue	6.5	6.9	6.8
Mustang	6.9	6.9	7.2
Brookston	6.4	6.8	6.4
Houndog	7.0	6.8	7.0
Clemfine	6.2	6.6	6.6
Ky 31	6.7	6.5	6.4
Olympic	6.1	6.5	6.6
Finelawn TF	6.6	6.5	6.0
LSD	0.3	0.5	0.5

Turf quality ratings on a 1 to 9 scale, with 9 = best.

A national turf-type tall fescue trial was established during the fall of 1983 and included 33 cultivars. The cultural procedures were the same as the previous trial.

Results. It is of interest to note that after one year's data, the tall fescue cultivar 'Adventure' was the top rated entry (Table 2) as it has been for 1983 and 1984 in the previous trial (Table 1). This trial was also established near Asheville, NC in 1983 under minimum maintenance and has limited data at present. A Coastal Plain turf-type tall fescue trial was established in moderate shade near Hampstead, NC in the fall of 1984 with eight cultivars and three mixtures. Initial stands were average but improved during the season. It will be interesting to see if satisfactory quality is maintained under the very sandy, shady conditions.

Table 2

National tall fescue trial

Entry	1984 Mean	Entry	1984 Mean
Adventure	7.72	Houndog	7.00
Unknown	7.44	Apache	6.94
Clemfine	7.44	Olympic	6.94
Finelawn I	7.39	KS-78-4	6.83
Arid	7.39	NK-82508	6.83
TF-813	7.33	Mustang	6.72
Falcon	7.33	Ky-31	6.72
5GL	7.28	51W	6.72
Maverick	7.22	562	6.67
Rebel	7.22	5D3	6.56
Syn-GA-1	7.11	5L4	6.44
Tempo	7.11	Festorina	6.33
Brookston	7.06	Barcel	6.33
ISI-C	7.06	Mes-FA-83-1	6.22
Johnstone	7.06	NK-81425	6.17
Jaguar	7.06	Kenhy	5.61
Willamette	7.00		
LSD	0.46		

Turf quality ratings on a 1 to 9 scale, with 9 = best.

The availability of tall fescue varieties and an estimate of prices are listed in Table 3.

Table 3

Tall Fescues

Variety	Var. Reg.	Availability	*	Variety	Var. Reg.	Availability	*
Adventure	17	Limited	S	Jaguar	4	Fair	S
Apache	15	Limited	S	Mustang	11	Fair	S
Brookston	14	Good	S	Olympic	15	Good	S
Falcon	2	Fair	S	Rebel	8	Good	S
Galway	9	Fair	S				

*Price: L = Lower, S = Stable, H = Higher

TALL FESCUE/BLUEGRASS MIXTURES FOR SHADE CONDITIONS

A tall fescue/Kentucky bluegrass mixture trial was established under shaded conditions during the fall of 1982, with cultural practices the same as the tall fescue trials.

Results. Turf quality scores for 1983 and 1984 are presented in Table 4. The top ranked entry in 1984 was Rebel tall fescue seeded along with a rating of 7.0. This was closely followed by the mixture of Rebel/Kenblue bluegrass/Glade bluegrass at 6.8. Six of the top 9 rated entries were Rebel with Glade bluegrass as part of the mixture. Rebel with Kenblue bluegrass declined from 1983 (6.4 rating) to a rating of 5.6 in 1984. This indicates superior performance of Rebel and Glade under shade. Houndog tall fescue improved from 1983 (6.2 rating) to 6.8 rating in 1984. Ky 31 tall fescue declined from a 6.3 rating to a 5.3 in 1984, as did all mixtures with Ky 31 even with Glade as part of the mixture.

Table 4

Turf quality* of tall fescue and tall fescue/Kentucky bluegrass mixtures under shade conditions during 1983-84, Raleigh, NC.

Entry**	1983	1984
Rebel/Kbl/Glade/Reliant (80/5/5/10)	7.1	6.3
Rebel/Kbl/Glade (90/5/5)	6.8	6.2
Rebel	6.7	7.0
Rebel/Kbl/Glade/Pennlawn (80/5/5/10)	6.7	6.1
Rebel/Kbl/Glade (80/10/10)	6.6	6.8
Houndog/Kbl (80/20)	6.6	6.2
Ky-31/Glade/Newport/Kbl (90/3/4/3)	6.5	5.7
Rebel/Kenblue (90/10)	6.4	5.6
Rebel/Kenblue (80/20)	6.4	5.6
Falcon/Kenblue (80/20)	6.4	5.9
Rebel/Kbl/Glade/Ensylva (80/5/5/10)	6.3	6.1
Ky-31/Glade/Newport/Kbl (90/3/4/3)	6.3	5.5
Ky-31	6.3	5.3
Ky-31/Kenblue (90/10)	6.2	4.8
Houndog	6.2	6.8
Ky-31/Kbl/Glade (90/5/5)	6.1	5.3
Ky-31/Kbl/Glade (80/10/10)	6.1	5.3
Falcon	6.1	6.1
Ky-31/Kenblue (80/20)	5.9	5.1
Bri/Vic/Ban/Jtwn/Bil (30/25/20/15/10)	5.7	4.7
Ky-31/NWP/CRF/CF/Car (35/21/34/3/3)	5.7	4.7
LSD	0.3	0.6

* Turf quality ratings on a 1 to 9 scale, with 9 = best and 5 as minimum acceptability.

**Kbl = Kenblue Kentucky bluegrass
Vic = Victa Kentucky bluegrass
Jtwn = Jamestown chewings fescue
NWP = Newport Kentucky bluegrass
CF = Common chewings fescue
Bri = Bristol Kentucky bluegrass
Ban = Banner chewings fescue
Bil = Biljart hard fescue
CRF = Common creeping red fescue
Car = Carpetgrass

KENTUCKY BLUEGRASSES

Cultural Procedures. The national Kentucky bluegrass cultivar evaluation trial was established in the fall of 1980 and contains 85 entries including both commercial and experimental cultivars. The turf was clipped at a 2-inch cutting height and received 2 pounds of N per 1000 square feet per year in split applications of one pound each in September and February. Plots were watered at the first sign of wilt.

Results. The top ten cultivars for the period 1981 through 1984 are presented in Table 5. The experimental cultivar PSU 173 is the only one that has ranked in the top 10 for the four years. Aspen, 239, and I-13 maintained high ratings, with Cello increasing from a 5.8 rating in 1983 to a 6.8 rating in 1984. Many other cultivars have had very good ratings for the four years of the trial (Table 7).

Table 5

National Kentucky bluegrass trial top ten cultivars, 1981-1984

1981		1982		1983		1984	
Cultivar	TQ*	Cultivar	TQ	Cultivar	TQ	Cultivar	TQ
CEBVB	7.4	Admiral	7.1	Aspen	7.1	Vanessa	6.9
225	7.3	225	6.9	225	7.0	PSU 190	6.8
MLM-18011	7.3	CEBVB-3965	6.7	239	6.9	Cello	6.7
Haga 463	7.2	Barblue	6.6	PSU-173	6.8	Sydsport	6.7
Fylking	7.2	PSU-173	6.6	Bonnieblue	6.7	PSU-173	6.6
Glade	7.2	MLM-18011	6.6	MLM-18011	6.7	Aspen	6.5
Monopoly	7.1	Wabash	6.6	Haga 463	6.6	TPI 96B	6.5
PSU-173	7.1	K3-179	6.6	I-13	6.6	Holiday	6.4
Victa	7.1	Glade	6.5	Banff	6.5	I-13	6.3
Mosa	7.0	H-7	6.5	Vantage	6.5	239	6.3

*Turf quality ratings on a 1 to 9 scale, with 9 = best.

The availability of Kentucky bluegrass varieties and an estimate of prices are listed in Table 6.

Table 6

Kentucky Bluegrasses

Variety	Var. Reg.	Availability	*	Variety	Var. Reg.	Availability	*
A-34 Ben Sun	13, 17	Good	S	Haga	2, 10	Fair	S
Adelphi	9	Good	S	Majestic	10	Fair	S
America	13	Fair	S	Merion	7	Limited	H
Aquila	1, 7, 9, 16	Limited	S	Merit	3	Good	S
Banff	13	Fair	S	Midnight	15	Fair	S
Baron	8, 10	Good	S	Mystic	8	Fair	S
Birka	2, 10	Limited	S	Nassau	7, 8	Fair	S
Bristol	13	V. poor	L	Nugget	7, 11, 12	Poor	S
Challenger	15	Limited	S	Parade	9	Limited	S
Cheri	7	Fair	H	Park	9	Good	S
Columbia	15	Good	H	Ram 1	7, 8	Fair	S
Eclipse	4	Limited	H	Rugby	14	Good	S
Fylking	7	Good	H	Sydsport	2, 10	Fair	S
Georgetown	8	Fair	S	Touchdown	11	Good	S
Geronimo	7	Poor	S	Victa	13	V. Good	L
Glade	7	Fair	H	Wabash	7	Limited	H

*Price: L = Lower, S = Stable, H = Higher

Table 7

Mean turf quality* scores from the National Kentucky Bluegrass Evaluation Trial for 1982-1984, Raleigh, NC

Entry	1982	1983	1984	Entry	1982	1983	1984	Entry	1982	1983	1984
Aspen	6.3	7.1	6.6	Ram I	5.9	6.3	6.0	Cello	5.9	5.8	6.8
225	6.9	7.0	5.9	PSU 150	6.4	6.3	5.9	A20-6A	5.9	5.8	5.6
239	6.6	6.9	6.3	Bristol	6.2	6.3	5.8	Mona	5.9	5.8	5.0
PSU 173	6.6	6.8	6.6	Enoble	5.8	6.3	6.0	Nassua	6.0	5.8	4.3
Bonnieblue	5.4	6.7	5.6	Bayside	6.3	6.3	5.8	K3-162	5.2	5.8	6.3
MLM 18011	6.6	6.7	5.6	Harmony	5.4	6.2	5.6	Kimono	5.4	5.8	6.3
Haga 463	6.4	6.6	6.2	Piedmont	5.8	6.2	5.5	Victa	6.2	5.8	5.5
I-13	6.4	6.6	6.4	America	6.1	6.2	5.5	Argyle	5.2	5.8	5.7
BANFF	6.0	6.5	6.0	Eclipse	6.2	6.2	5.9	Midnight	6.2	5.8	5.6
Vantage	5.6	6.5	5.7	Majestic	5.7	6.2	5.6	Merit	5.6	5.7	6.1
BA 6191	6.0	6.5	6.1	Sydsport	5.6	6.2	6.8	Apart	5.9	5.7	4.7
K1-152	6.2	6.5	5.3	Per PP300	6.2	6.2	5.6	Welcome	5.6	5.6	5.7
Baron	6.4	6.5	5.3	Somerset	6.4	6.2	5.8	K3-178	6.3	5.6	6.0
CEBVB 3965	6.7	6.5	6.0	Barblue	6.6	6.2	5.7	Merion	5.0	5.5	5.9
H-7	6.5	6.5	5.6	Wabash	5.5	6.1	5.4	Mystic	5.2	5.5	6.0
K3-179	6.6	6.5	5.7	Birka	6.0	6.1	5.4	Trenton	5.3	5.5	5.8
Cheri	6.4	6.5	5.1	PSU 190	5.7	6.1	6.8	Kenblue	5.0	5.4	5.3
Plush	6.0	6.4	5.3	Monopoly	6.0	6.0	5.6	Nugget	5.7	5.4	5.4
Vanessa	6.1	6.4	6.9	Fylking	6.2	6.0	5.7	A20	5.5	5.4	5.3
Glade	6.5	6.4	5.4	Rugby	5.8	6.0	6.3	WWAG 478	5.9	5.3	4.8
WWAG 480	5.5	6.4	5.8	Mosa	6.0	6.0	5.9	Escort	5.5	5.3	4.7
A-34	5.7	6.4	6.3	A20-6	6.2	6.0	6.3	SV-01617	5.5	5.2	5.0
NJ 735	6.5	6.4	5.8	Shasta	6.1	6.0	6.0	Lovegreen	5.4	5.0	4.7
Adelphi	5.8	6.4	6.0	Charlotte	6.0	6.0	6.3	SD Common	4.6	4.8	4.9
Enmundi	6.3	6.4	6.0	Parade	6.5	6.0	4.8	Touchdown	5.3	4.4	5.8
Holiday	6.0	6.4	6.5	Challenger	6.0	6.0	5.5				
Geronimo	6.0	6.4	6.0	Dormie	5.3	5.9	6.2				
TPI-963	6.2	6.4	6.5	Bono	6.0	5.9	5.8				
Admiral	7.1	6.3	5.6	Mer PP43	5.4	5.9	5.1				
Columbia	6.0	6.3	5.9	S-21	5.3	5.8	5.4				
LSD	0.5	0.6	0.5								

* Turf quality ratings on a 1 to 9 scale, with 9 = best and 5 as minimum acceptability.

FINE-LEAF FESCUES.

Cultural Procedures. A National fine-leaf fescue trial was established during the fall of 1983 and included 46 cultivars. The cultural procedures were the same as the tall fescue trials. In addition, this trial was also established near Asheville, NC in 1983 under minimum maintenance.

Results. For many years, the fine-leaf fescues have performed poorly in the Raleigh area, becoming thin and clumpy in a short time. Several of the varieties in the National test are exhibiting these traits in the second year. However, many of the newer entries have excellent stands. The hard fescues are of particular interest due to the lower maintenance requirements. The data in Table 8 has Spartan hard fescue as top rated, and a total of 4 cultivars in the top 15, but one year's data should be viewed with caution.

Table 8

National fine-leaf fescue trial

Entry	1984 Mean	Entry	1984 Mean
Spartan, H	7.33	Center, Ch	6.07
Longfellow, Ch	7.00	Wilma, Ch	6.07
4 FL, Ch	6.93	Boreal, CR	6.07
Enjoy, Ch	6.80	Waldina, H	5.93
Scaldis, H	6.80	Estica, CR	5.93
CF - 2, Ch	6.73	Magenta, Ch	5.87
Flyer, CR	6.73	Jamestown, Ch	5.87
430, CR	6.67	BAR Fo, H	5.87
Waldorf, Ch	6.67	Ensylva, CR	5.87
ST - 2, H	6.60	Valda, H	5.80
Tamara, Ch	6.60	Banner, Ch	5.73
Pernille, CR	6.47	Unknown ?	5.73
Beauty, Ch	6.40	Biljart, H	5.73
FRI - FRT 83-1 ?	6.33	Pennlawn, CR	5.60
Reliant, H	6.27	Ruby, CR	5.60
Lovisa, CR	6.27	Ivalo, Ch	5.40
HF 9-3, Ch	6.27	Koket, Ch	5.33
Epsom, Ch	6.27	Commodore, CR	5.33
Atlanta, Ch	6.27	Tatjana, Ch	5.27
Checker, Ch	6.20	Highlight, Ch	5.20
Aurora, H	6.20	Robot, CR	5.07
Shadow, Ch	6.20	Ceres, CR	4.87
Mary, Ch	6.13	Wintergreen, CR	4.60
LSD	0.60		

H = hard; Ch = chewings; CR = creeping red

Turf quality ratings on a 1 to 9 scale, with 9 = best.

PERENNIAL RYEGRASSES

Cultural Procedures. A national perennial ryegrass cultivar trial was seeded in the fall of 1982 at 5.5 pounds pure live seed per 1000 square feet. The 53 entries in this trial are being maintained at a 2 inch cutting height and receive 2 pounds N per 1000 square feet per year as split applications of one pound in September and February.

Results. The top 10 named cultivars for 1984 were Citation II, Pennant, All Star, Blazer, Birdie II, Delray, Gator, Premier, Prelude, and Ranger (Table 9). The management of the trial with the high cut and low fertilization is similar to that of the tall fescue trials and the results would be expected to be different from that of a golf green overseeding. The endophyte level in the seed has been reported for several of the entries, with Citation II having a level of 94% and Birdie II over 80%. The endophyte is a fungus that has no effect on quality, but enhances resistance to bill bugs, sod webworms and chinch bugs, along with other above ground feeding insects.

A national overseeding trial for golf greens with 54 entries was seeded at the Turf Center and also at Belvedere Plantation near Hampstead, NC in the fall of 1984.

Table 9

National perennial ryegrass trial

Entry	1983 Mean	1984 Mean	Entry	1983 Mean	1984 Mean
SWRC-1	6.30	6.67	2-ED	6.37	5.75
M382	5.67	6.67	Dasher	5.33	5.75
HR-1	6.37	6.38	Pennfine	5.87	5.71
IA 728	5.87	6.38	HE 168	6.43	5.67
Citation II	6.60	6.38	Barry	6.37	5.63
Pennant	5.43	6.29	Elka	6.33	5.58
All Star	6.23	6.29	NK 80389	6.13	5.50
Blazer	6.60	6.17	Omega	5.73	5.50
Birdie II	6.03	6.04	Crown	4.83	5.46
Delray	5.93	6.04	Manhattan	5.50	5.46
Gator	5.93	6.04	Manhattan II	5.33	5.42
Premir	5.77	6.04	Fiesta	5.13	5.78
Prelude	5.23	5.96	Cockade	5.73	5.33
Ranger	6.43	5.96	WWE 19	5.83	5.24
ISl 90	6.37	5.92	Citation	6.80	5.29
Palmer	5.47	5.92	Yorktown II	5.33	5.25
Derby	6.07	5.92	Goalie	4.77	5.21
NK 79309	6.17	5.92	Diplomat	5.63	5.17
LP 736	5.67	5.88	LP 702	5.33	5.13
Regal	5.83	5.88	LP 210	5.43	5.00
NK 79307	5.90	5.83	LP 792	4.73	4.96
Cigil	5.80	5.83	Barclay	5.23	4.78
Cowboy	5.40	5.83	Cupido	5.20	4.70
HE 178	5.70	5.79	Pippin	5.77	4.63
Acclaim	6.03	5.79	HE 131	5.27	4.63
BT-1	5.50	5.79	Caravelle	5.27	4.33
			Lynn	4.83	4.21
LSD	0.65	0.57			

Turf quality ratings on a 1 to 9 scale, with 9 = best.

The availability of fine-leaf fescue varieties and an estimate of price are listed in Table 10.

Table 10

Fine-leaf Fescues

Variety	Var. Reg.	Availability	*	Variety	Var. Reg.	Availability	*
Agram, Ch	11	Good	S	Highlight, Ch	10	Fair	S
Atlanta, Ch	9	Good	S	Reptans, CR	10	Good	S
Aurora, H	15	Limited	S	Ruby, H	9	Good	S
Banner, Ch	10	Good	S	Scaldis, H	9	Good	S
Biljart, H	10	Good	S	Shadow, Ch	15	Good	S
Dawson, CR	9	Good	S	Tournament, H	11	Fair	S
Fortress, CR	10	Good	S	Waldina, H	15	Good	S

Ch = Chewings, H = Hard, CR = Creeping Red

*Price: L = lower, S = Stable, H = Higher

The availability of fine-leaf perennial ryegrass varieties and an estimate of prices are listed in Table 11.

Table 11

Fine-Leaf Perennial Ryegrass

Variety	Var. Reg.	Availability	*	Variety	Var. Reg.	Availability	*
All-Star	1, 6, 7 16	Poor	S	Manhattan	14	Good	L
Birdie II	15	Good	L	Manhattan II	14	Good	L
Blazer	11	Good	S	NK 200	9	Limited	S
Caravelle	13	Good	S	Nuriea	10	Good	S
Citation II	15	Fair	L	Omega	4, 10	Good	S
Delray	9	Good	S	Omega II	4, 15	Limited	S
Eton	9	Good	S	Pennant	2	Good	S
Fiesta	11	Good	S	Pennfine	14	Good	L
Goalie	9	Good	S	Yorktown II	10	Good	S
Loretta	13	V. good	S				

*Price: L = Lower, S = Stable, H = Higher

The companies participating in the seed survey are listed in Table 12. The number of the company corresponds with the number in the column Var. Reg. in the availability tables.

Table 12

Variety Registrants

Companies participating in seed survey:

1. J & L Adikes, Inc. 182-12 93rd Ave. Jamaica, NY 11423 212-739-4400
2. E. F. Burlingham & Sons, 1936 19th Ave., P.O. Box 217 Forest Grove, OR 97116 503-357-2141
3. Full Circle, Inc. P. O. Box 49, Madras, OR 97741, 503-475-3877
4. Garfield Williamson, Inc. 1072 West Side Ave., Jersey City, NJ 07306, 201-435-3500
5. Geo W. Hill & Co. 8010 Dixie Hwy. P.O. Box 787, Florence, KY 41042, 606-371-8423
6. International Seeds, Inc. 820 First St. Halsey, OR 97348, 503-369-2251
7. Jacklin Seed, Co. W. 5300 Jacklin Ave. Post Falls, ID 83854, 208-773-7581
8. Loft Seed Co., Chimney Rock Rd. P.O. Box 146, Bound Brook NJ 08805, 201-356-8700
9. Northrup King Co., 1500 N.E. Jackson St., Mineapolis, MN 55413, 612-781-8011
10. Oseco, Inc. P.O. Box 219, Brampton, ON L6V 2L2, Canada, 416-846-5080
11. Otto Pick & Sons Seeds Ltd., Box 126, Richmond Hill, ON L4C 4X9, Canada, 416-884-1147
12. Pickseed West, Inc. P.O. Box 888, Tangent, OR 97389, 503-926-8886
13. O. M. Scott & Sons Co. Proturf Div., Marysville, OH 43040, 513-644-0011
14. Stanford Seed, Co. 560 Fulton St., P.O. Box 366, Buffalo, NY 14240. 716-825-3300
15. Turf Seed Inc., P.O. Box 250, Hubbard, OR 97032, 503-981-9571
16. Vaughan's Seed Co. Chimney Rock Rd., Bound Brook, NJ 08805, 201-356-4200
17. Warren's Turf Nursery, Inc. Seed Div. P.O. Box 459, Suisun City, CA 94585, 800-828-8873

SEED AND SOD CERTIFICATION IN NORTH CAROLINA

Foil W. McLaughlin, Director
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Before specifically discussing the sod certification program in North Carolina perhaps I should describe briefly the certification program and how it is carried out in this state. The North Carolina Crop Improvement Association is designated by state law as the official agency for the certification of seed and other plant materials in North Carolina. The Association had its origin in the Crops and Plant Breeding Department (now Crop Science) at North Carolina State University and was officially organized in 1929.

Membership in the Association is open to any person or firm who makes or desires to make seed growing a specific part of their farming operation. Any other person or organization interested in promoting the work of the Association may also become a member.

The Association, under the leadership of personnel of North Carolina State University establishes and administers standards for certification and inspects the production of certified seed (or sod) under those standards. The business of the corporation is managed by a board of directors. The Association office, located on the University campus, is responsible for inspection, records, issuance of tags and for other administrative duties.

The purpose and objectives of the Association are three: (1) to encourage the production of high quality seed (including plants and sod) grown and distributed under controlled conditions to assure proper identity and purity; (2) to encourage the use of improved seed/sod; and (3) to certify only crops and varieties accepted by the Association.

This program, therefore, provides a means for new varieties developed by plant breeders to be increased to a volume that will benefit the consumers. Other varieties that have been in use for years must also be kept pure from year to year. In both new and older varieties, there is danger of mixtures through careless handling. Certification offers a program of planned production whereby desirable varietal and seed purity is maintained.

The maintenance program of certification can best be described as a "seed chain" with four classes: Breeder, Foundation, Registered and Certified. The <u>Breeder Seed</u> is maintained or produced by the plant breeder who developed the variety. Once a variety is released it is the breeder's responsibility to produce a small quantity of seed on a

continuing basis - representrative of the characteristic of the variety as released. This breeder seed is the key to a good certification program. Foundation Seed is the next generation increase from breeder seed. This seed is grown by the private seed company, or, if a public variety, by the North Carolina Foundation Seed Producers. Foundation Seed is officially labeled with a white tag and used by the certified growers to produce Registered or Certified Seed. The registered seed is the next generation increase from foundation seed and is labeled with a purple tag. The last increase permitted in a certification program is the certified seed labeled with the official blue tag.

Through this "seed chain" - breeder, foundation, registered, certified - is made available to cooperating growers an unbiased and rigid inspection service. All applications for certification are made voluntarily. The grower of seed (or sod) must accept an obligation to uphold the high standards for certification and agree to abide by the rules and regulations of the Association.

Procedures for the production of certified seed or sod can be described as follows: (1) a grower must become familiar with the certification standards and procedures (See: North Carolina Certification Handbook); (2) plant seed that is eligible for certification on land that has proper rotation; (3) make application for crop certification to the Crop Improvement Association whose personnel will make the inspections to see that all standards are met; (4) if a seed crop, the seed must be harvested, conditioned and tested or if plants or sod and the field passes inspection an official label is issued for use in marketing the crop.

We do have a fairly large certification program in North Carolina. This past year we certified 170,000 acres valued at over 70 million dollars. The certification programs nationwide involved 3.6 million acres. I should tell you that each state has an official certifying agency which operates very similarly to that described for North Carolina.

The program for the certification of turfgrasses and sod in North Carolina is relatively small - only a couple hundred acres. But we do have as excellent program developed jointly by Univeristy personnel and the Crop Improvement Association.

The turfgrass certification generally involves those species that are reproduced vegetatively. That is, the production of a pure stand of one species, such as Tifgreen Bermuda, involves the planting of either Foundation or Registered sprigs, stolons or rhizomes on land that is free of any other bermudagrasses or objectionable weeds. The turfgrass fields are then inspected during the growing season to determine variety purity and the presence of any objectionable weeds or other crop mixtures. If all certification standards are met then official blue certification tags may be used to market the turfgrass.

Turfgrass sod certification, on the other hand, involves the same procedures except that instead of the vegetatively reproduced species, these crops include only those reproduced by seed. Species involved are bluegrass, the fescues and mixtures of desirable turfgrass species. Certified seed must be planted and the fields free of objectionable weeds and other crop species. Field inspections are required. At the present time the standards specify an early spring inspection and another in mid-summer. We feel that it may be desirable to make another inspection of the sod fields shortly after emergence. As in the case of all certification, if all standards and requirements are met an official blue certified tag may be issued for use in the marketing of the sod.

As I said earlier, I think we have a good certification program in place for use in North Carolina. We of the North Carolina Crop Improvement Association and the University stand ready to cooperate with those sod producers that wish to involve certification. Just let us know. Our offices are on the NC State University campus in Raleigh.

Thank you for giving me an opportunity to tell you a little about the certification program for North Carolina.

SOD INSTALLATION AND CARE

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Sodding offers fast establishment, reduced erosion problems and better performance on high use areas such as athletic fields compared to the traditional method of seeding. In addition, sod can sometimes be used at times when seeding is not an option. Higher costs and limited availability of plant material are the major disadvantages.

If possible, plant certified sod of adapted cultivars for your locality and be cautious of bargains. Purchase planting material that contains the lowest amount of weed and crop content and that is free of objectionable turfgrasses. Such planting material often contains hard-to-control perennial grassy weeds that reduce turf quality for years to come.

Cool season grass sod is best installed in the fall, but can be laid any time the ground is not frozen. Warm season grasses are best sodded in the spring or early summer after soil temperatures reach 50 F. Sod is often laid under less than optimum conditions but the chance of success is reduced. Research is currently underway at North Carolina State University to determine if various management practices or chemical treatments can enhance bermudagrass sod establishment.

INSTALLATION

Installation begins with proper site preparation. Remove debris and perennial grassy weeds using a non-selective herbicide. Remove topsoil if present, shape the underlying soil to the proper contour, grade and redistribute the topsoil evenly over the surface. Water the area and fill in areas that settle to avoid standing water. If topsoil or amnedments are not used, loosen the subsoil to a depth of 6 to 8 inches to reduce compaction and enhance root growth. Make sure the soil is not overly moist when preparing the site so that soil tilth is maintained.

Fertilizer and lime should be applied based on a soil test and thoroughly incorporated into the top 6 to 8 inches using a roto tiller or disk. Insure that the sample being submitted is truly representative of the site by taking 15 soil cores preferably to a 4 inch depth and thoroughly mixing them in a plastic container or paper bag. Submit samples to the Extension service for testing by the North Carolina

Department of Agriculture. Contact your Extension office for recommendations if a soil test cannot be taken.

Rake or harrow the site to establish a smooth and level final grade. Soil particles should be no larger than golf ball size and preferably the size of pea gravel. Water thoroughly and roll or cultipack lightly to firm the soil. Hand rake to break up the crusty surface prior to sodding. The finished grade should be about 1 1/2 inches below walks and drives.

Stacked or rolled sod tends to build up heat that can be harmful to the grass plants that make up the sod. For this reason, every effort should be made to reduce the time that the sod is left in this condition. Plan to have the final grading done prior to the delivery of the sod and insure that enough workers and appropriate equipment are on hand to quickly and effectively lay the sod. Check to insure that the sod is in good condition at time of arrival. Sod should be laid within 24 hours after harvest during warm weather and no later than 48 hours after delivery. Sod should be placed in the shade to lessen the chance of heat buildup during the installation process. Plan to unstack and unroll sod if sod cannot be laid within 48 hours or the sod is showing signs of severe wilt. Moistening the sod after it is unrolled will help maintain viability.

The soil should be moist but not overly wet at time of installation. Avoid laying sod on dry soil. This can be accomplished by irrigating the area several days in advance of delivery. Start sodding from a straight edge and butt strips together, staggering them in a brick-like pattern. Make sure the edges are not overlapping. Avoid stretching sod and use a knife or sharp spade for trimming to fit irregularly shaped areas. Lay sod lengthwise across the face of a slope and peg or stake sod pieces to prevent slippage. Have soil on hand to add between sod pieces that do not butt properly to prevent drying of edges. Roll the sod to ensure good soil-sod contact and begin watering.

CARE

Thoroughly water the sod immediately after rolling making sure that the soil underneath is wet. Sod should be kept continually moist by daily watering until the the sod starts to root. This can be determined by gently tugging on the sod and determining if their is any resistance. Resistance is an indication that rooting is occuring. Rooting normally requires 2 to 3 weeks. Watering can be

reduced gradually to once a week after the sod is fully pegged down.

Begin mowing as the grass resumes growth and reaches 30 to 40 percent over the desired mowing height. Make sure that it is mowed just prior to scheduled irrigation to lessen the chance of increasing compaction and bogging down of equipment. Use a mower with a sharp blade.

After the sod is rooted, follow a fertilization schedule suggested for established lawns. A high phosphorus (starter fertilizer) applied three to four weeks after installation may assist in rooting.

Avoid the use of herbicides, until the sod is fully established and the turf has been mowed 3 to 4 times. Cool season grasses may need to be treated with a fungicide if sod is laid during hot weather or with an insecticide if harmful insects are present at damaging levels.

Good management practices such as proper mowing , watering and fertilization will be key to maintaining a high quality turf.

Persistence of Diquat, Endothall, and Fluridone in North Carolina Farm Ponds

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Previous studies have shown that diquat, endothall, and fluridone are not persistent in the environment. Data, however, is often quite variable and persistence can be affected by environmental parameters such as water quality and biota. The major routes of dissipation from water are as follows: diquat, adsorption to particulates, absorption by plants and microbial degradation; fluridone, absorption to hydrosoil and photochemical degradation.

The purpose of this study was to measure the persistence of the aquatic herbicides diquat, endothall, and fluridone in farm ponds so that better recommendations could be made as to the use of these compounds for aquatic weed control in farm ponds and golf course water hazards that are used as a source of irrigation water.

Several ponds were chosen that had negligible inflow and outflow. Diquat, as Diquat Herbicide H/A, endothall as Aquathol K, or fluridone as Sonar 4AS or Sonar 5P were applied as whole pond treatments to the ponds at various rates and on different dates (Table 1). Water temperature (surface) in all ponds was 67 F at the time of treatment. All liquid formulations wre applied as surface sprays without adjuvants. Sonar 5P was applied with a granular applicator. Water samples were collected from diquat treated ponds at 0.25, 0.5, 1, 1.5, 2, 2.5, 3, 4, 7, and 16 days after treatment (DAT); from endothall treated ponds at 0.25, 0.5, 0.75, 1, 1.25, 1.75, 2, 3, 4, 7, and 21 DAT; and from fluridone treated ponds at various time intervals between 1 and 62 DAT. One liter composite water column samples, between the surface and bottom, were collected at three established sample stations in each pond. Aloquats of 333 ml from each sample station were then combined for a single composite sample from each pond at each sample time. All samples were stored frozen in opaque plastic bottles until analyses were conducted.

Table 1. Application rates and dates of herbicide application to ponds used to study the persistence of diquat, endothall and fluridone in water.

Pond Name	Herbicide	Application rate (lb ai/A)	Application date
Jenks	diquat	11.1	5/1/84
Smith	diquat	12.5	5/1/84
Rogers	diquat	13.8	5/1/84
Apex	fluridone 4AS	2.0	5/24/84
Whispering Pines	fluridone 4AS	1.0	5/9/84
Virginia	fluridone 5P	1.0	5/10/84
Mangum -A	endothall	15.10	5/20/84
Mangum -B	endothall	18.75	5/20/84

Diquat dissipated very quickly from all treated ponds (Figure 1), even more rapid dissipation than is reported in the literature. This can probably be explained by rapid absorption by the fairly dense infestations of filamentous algae (Pithophora oedogoniana) and watermeal (Wolfia floridana), and by rapid adsorption to the high clay particulate content that is characteristic of piedmont impoundments. Since rainfall did not occur during the sampling period, dissipation can be assumed dilution and diffusion free.

Statistical analysis showed that the rates of dissipation were greater with increasing initial concentrations. The regression equations, however, predict essentially the same time after treatment to reach zero concentration of diquat in the water. These were 33 hours in Smith Pond and Rogers Pond and 30 hours in Jenks Pond.

Diquat was not detected in any of the ponds between the 36 hour sampling and the 16 day sampling suggesting that release back into the water from stressed or decaying vegetation did not occur.

Endothall did not dissipate from water as quickly as diquat, however, it was not persistent in water of the treated ponds. This observation agrees with the literature. No change in endothall concentration was observed between 6 hours and 6 days after treatment (Figure 2). After 21 days the endothall concentration was reduced by 75% and was approaching the lower limit of detection. Heavy precipitation (c.a. 6 in.) fell on the ponds and watershed between the 7 day and 21 day sample. This could have caused some dilution of the herbicide. However, due to the consistency with which endothall has been shown to disappear within 25 days we feel the effect of dilution is negligible.

Fluridone was more persistent in water than either diquat or endothall. The two ponds that were treated with the liquid formulation of fluridone showed constant dissipation with very slight unexplained variability. The regression equations predict zero concentration of fluridone after 60 days and 100 days in the two ponds. This data agrees well with literature data where the time to reach no detectable residue levels (0.0-5.0 ppb) were between 2 months and 12 months.

Fluridone concentrations responded somewhat differently in the pond treated with the 5P formulation. Maximum fluridone concentration was not observed until 17 days after treatment (Figure 3). This response was expected and reflects the time required for fluridone to become disassociated from the clay carrier. After this, fluridone steadily declined in concentration until 51 days after treatment when an increase in fluridone concentration was observed. A similar increase in concentration occurred in the Whispering Pines Pond 24 days after treatment (Figure 3). Although the time sequence is somewhat different, we believe that both of these increases in concentration reflect release of fluridone back into the water from stressed vegetation. Both Whispering Pines and Virginia Pond were heavily vegetated with profilerating spikerush (Eleocharis baldwinii) whereas Apex Pond had little vegetation and a similar increase in concentration was not observed.

Fluridone was much more persistent in the Virginia Pond than in the other two ponds. Variability in fluridone persistence in enclosed ponds can be explained by environmental factors that effect photolysis of the compound. In Virginia Pond a major factor was probably the heavy shading over the pond and shading from spikerush in the water that reduced photolysis. Both Apex Pond and Whispering Pines Pond are relatively unprotected.

Conclusion

Persistence of diquat, endothall, and fluridone observed in the Piedmont North Carolina ponds in this study was similar to persistence reported for these herbicides in small ponds of other geographical locations. If pondwater is to be used for irrigation of ornamentals and turfgrass, diquat is the safest choice of the three aquatic herbicides tested because of its very low persistence in water. If ornamentals and turf other than bentgrass are to be irrigated, an endothall compound would be the next safest

choice if the waiting times on the label are followed. If the water is used only to irrigate bentgrass, it may be used immediately following application of the herbicide to the water. Because of the relative persistence of fluridone in water, caution shoud be used in applying fluridone to irrigation water until more information is available on sensitivity of turf, ornamentals and crops.

We express appreciation to Chevron Chemical Company for providing Diquat H/A; to Pennwalt Corporation for providing Aquathol K and conducting endothall analyses; to Elanco Products Company for providing Sonar, financial assistance, and technical suggestions; and the University of North Carolina Water Resources Research Insititute for funding.

Use of brand names in this publication does not imply endorsement of the products named or criticism of similar ones not mentioned.

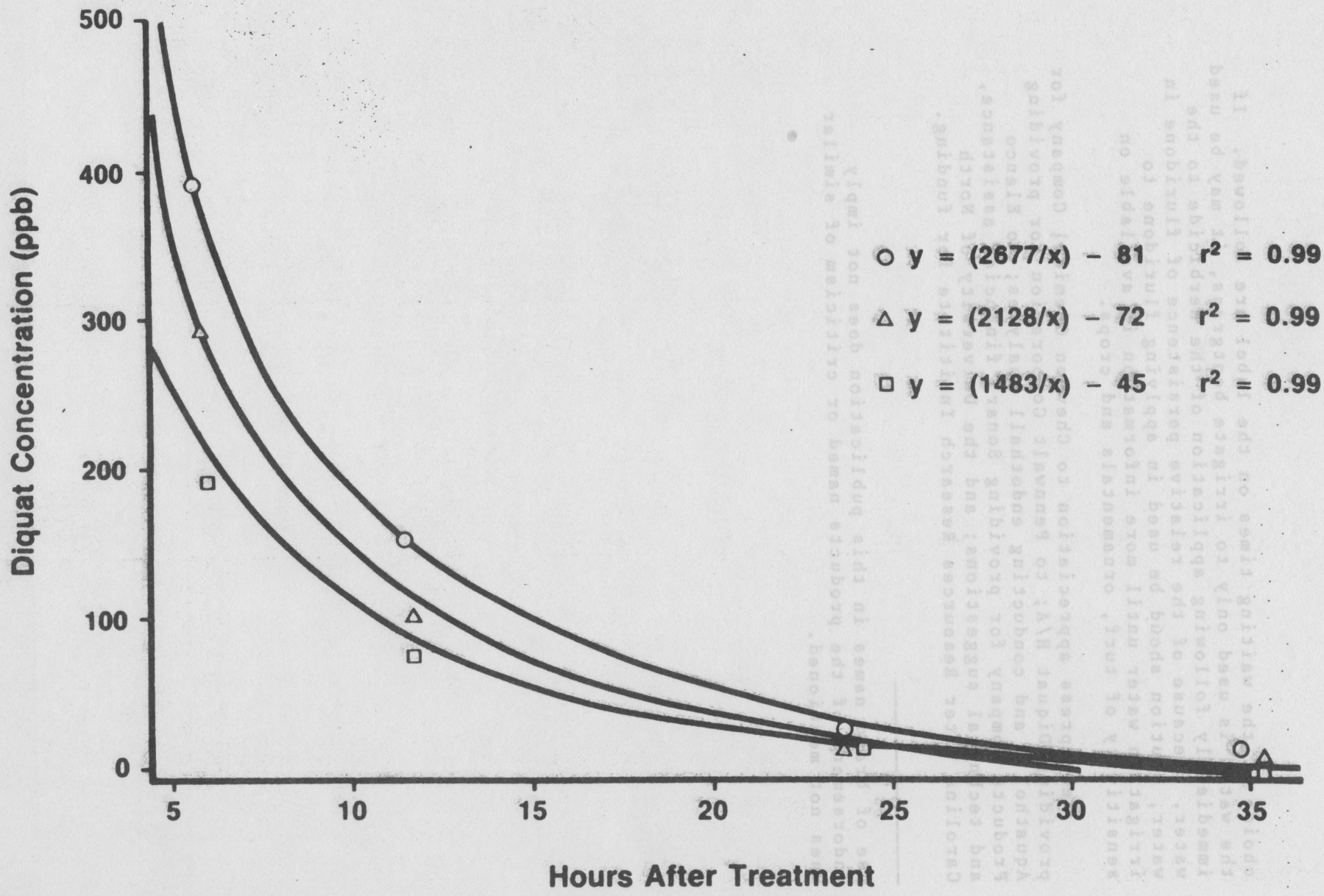

Figure 1. Dissipation of diquat from three Piedmont North Carolina ponds.

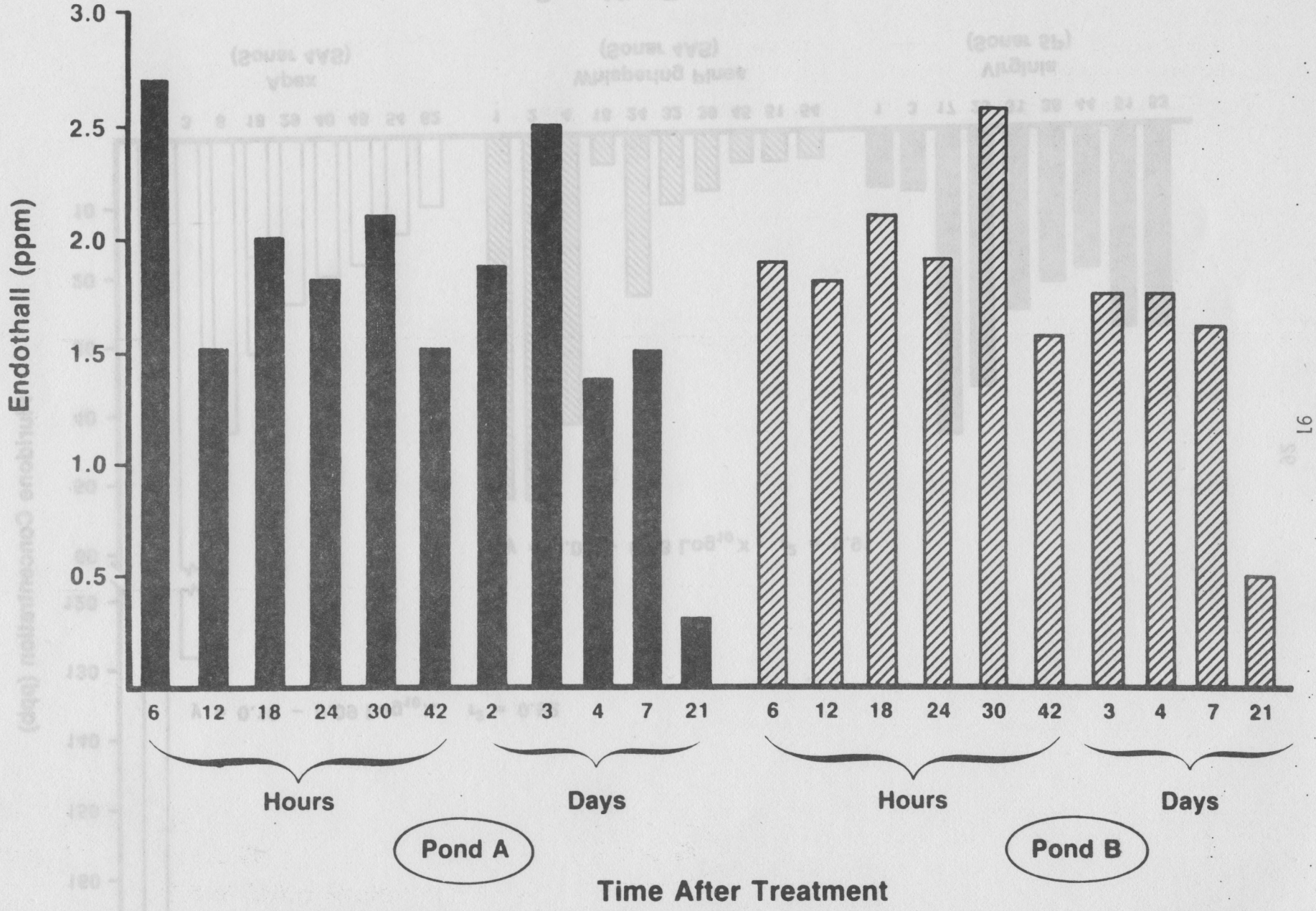

Figure 2. Dissipation of endothall from two Piedmont North Carolina ponds.

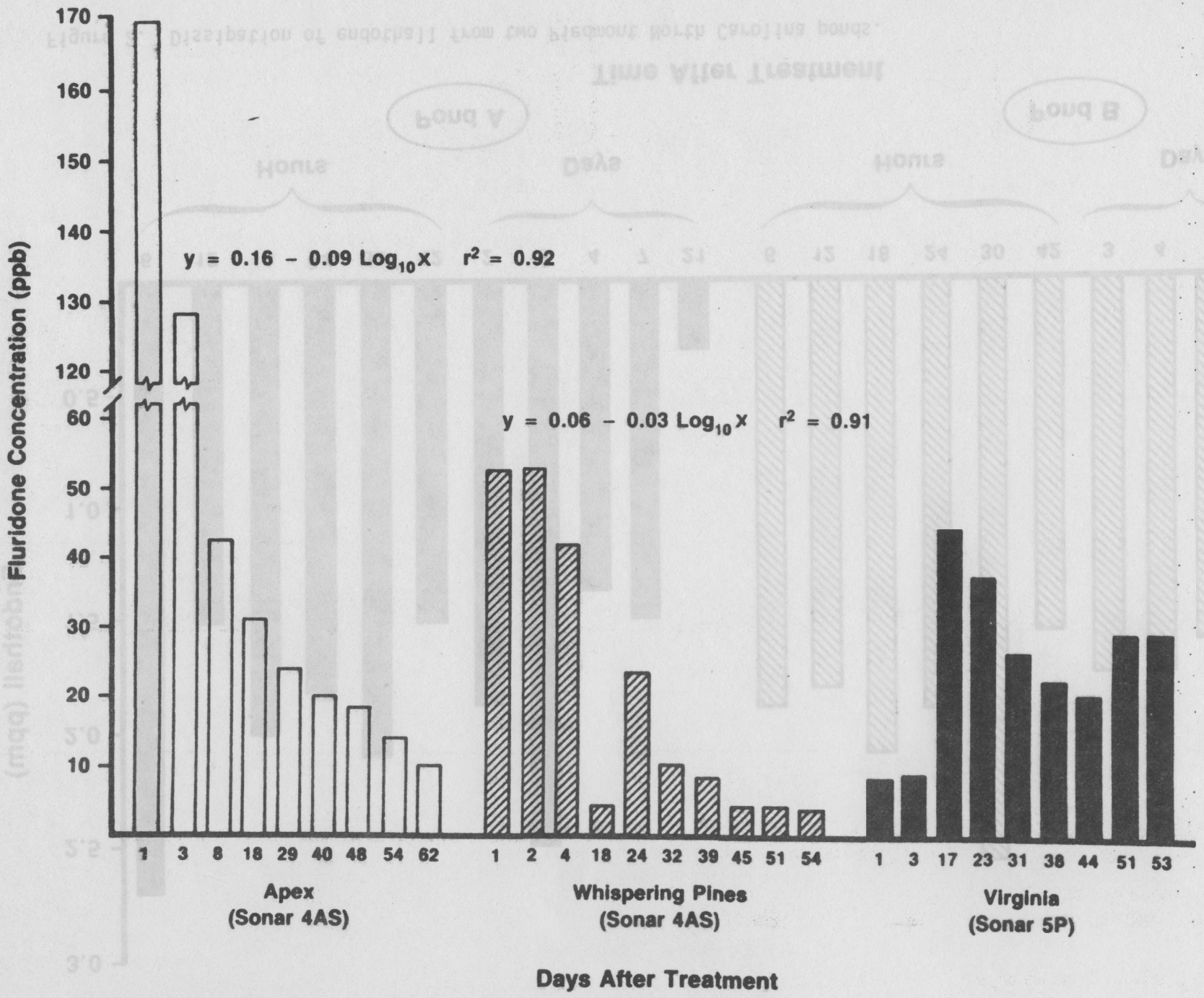

Figure 3. Dissipation of fluridone from three Piedmont North Carolina ponds.

ENDOPHYTIC FUNGI CAN SERVE AS BIOLOGICAL INSECT CONTROL IN TURFGRASSES

Dr. Richard Hurley
Lofts Seed Inc.
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Plant breeders are continually developing new varieties in which desirable characteristics and plant performance are optimized. Plant performance is a reflection of the sum total of many factors, including yield or productivity, appearance, vigor, resistance to weed invasion, recovery from injury, persistence and density, and can be enhanced by improving pest resistance and tolerance of herbicides, defoliation, heat and drought.

Resistance to insect predation is a very important factor in a plant's performance, which can be controlled three ways: (1) by using insect-resistant plant varieties; (2) by chemical pest control; and (3) by biological pest control.

Plant breeders continually seek to upgrade the insect resistance of important plant varieties; however, after a new variety providing resistance is developed, usually after years of painstaking breeding, insects may sooner or later evolve that are able to feed, without adverse effect, on the once insect-resistant plant. Thus, the ultimate grower of the new variety is faced with a number of alternatives. He can either await further development of a new pest-resistant plant variety or turn to either chemical pesticides or bilogical pest control.

If the cost or environmental impact of using chemical pesticides is a prohibiting factor, an alternative is biological pest control.

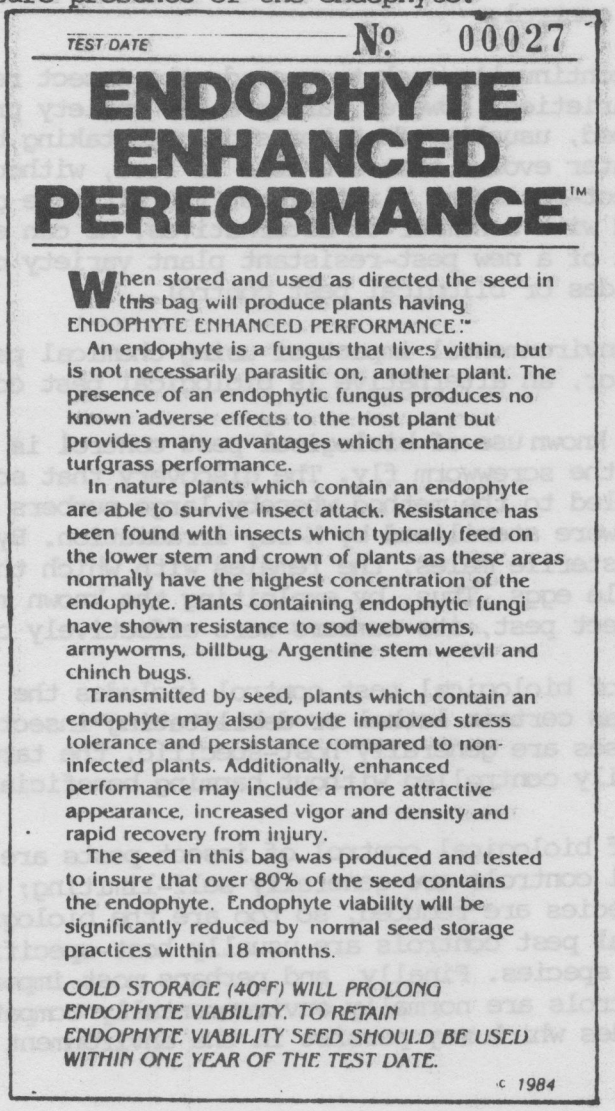
Perhaps the best known use of biological pest control is the well publicized case of the screwworm fly. The discovery that screwworm flies mated only once led to the method whereby large numbers of laboratory-bred male flies were sterilized by X-ray irradiation. By subsequently releasing these sterile males, the females with which they mated could lay only infertile eggs. Thus, by exploiting the known mating habits of a particular insect pest, its numbers were effectively curtailed.

Another example of biological pest control includes the use of insect pathogens, such as certain lethal or debilitating insect viruses. Because these viruses are generally host-specific, the targeted insect pest can be readily controlled without harming beneficial species.

The advantages of biological control of insect pests are several. First, biological controls are generally self-limiting; once numbers of the target species are reduced, so too are the biological controls. Second, biological pest controls are usually host-specific and do not attack desirable species. Finally, and perhaps most importantly, biological pest controls are normally environmentally compatible, unlike chemical pesticides which may persist in the environment and kill indiscriminately.

A "new" biological pest control has recently been recognized. Certain plants host symbiotic endophytic fungi which confer, among other things, an enhanced resistance to insect predation on the host plant. For example, in perennial ryegrasses, a positive association has been demonstrated between the presence of an endophytic fungus (literally, a fungus living within its plant host) and resistance of the plant to attack by some of the most prevalent insect infestations encountered in the field - i.e., the sod webworm, the bluegrass billbug, the Argentine stem weevil, the Southern armyworm, and the chinch bug.

When purchasing seed to contain high endophyte levels, look for the following tag to ensure presence of the endophyte.



TEST DATE _____ No. 00027

ENDOPHYTE ENHANCED PERFORMANCE™

When stored and used as directed the seed in this bag will produce plants having ENDOPHYTE ENHANCED PERFORMANCE."

An endophyte is a fungus that lives within, but is not necessarily parasitic on, another plant. The presence of an endophytic fungus produces no known adverse effects to the host plant but provides many advantages which enhance turfgrass performance.

In nature plants which contain an endophyte are able to survive insect attack. Resistance has been found with insects which typically feed on the lower stem and crown of plants as these areas normally have the highest concentration of the endophyte. Plants containing endophytic fungi have shown resistance to sod webworms, armyworms, billbug, Argentine stem weevil and chinch bugs.

Transmitted by seed, plants which contain an endophyte may also provide improved stress tolerance and persistance compared to non-infected plants. Additionally, enhanced performance may include a more attractive appearance, increased vigor and density and rapid recovery from injury.

The seed in this bag was produced and tested to insure that over 80% of the seed contains the endophyte. Endophyte viability will be significantly reduced by normal seed storage practices within 18 months.

COLD STORAGE (40°F) WILL PROLONG ENDOPHYTE VIABILITY. TO RETAIN ENDOPHYTE VIABILITY SEED SHOULD BE USED WITHIN ONE YEAR OF THE TEST DATE.

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In particular, perennial ryegrasses hosting an endophytic fungus are highly resistant to feeding of the larval stages of sod webworms. Plants lacking the endophytic fungus can sustain substantial injury from feeding by sod webworm larvae. Resistance in ryegrasses hosting this fungus to feeding of the larval stages of the bluegrass billbug has also been observed. Also, we have observed resistance to feeding by the chinch bug, and others have observed resistance in ryegrasses hosting endophytic fungus to the Argentine stem weevil. This endophytic-enhanced insect resistance in ryegrasses to three different orders of very prevalent chewing insects provide a broad-based mechanism for developing new plants having enhanced performance including resistance to these insects.

The exact mechanism of this enhanced resistance to insect predation has not as yet been identified, although it is suspected that such resistance could involve the generation of chemicals toxic to insects feeding on plants containing the endophytic fungi. These chemicals might be produced by the endophytic fungus or by the host plants themselves in response to the invading fungus. The latter mechanism may mediate a generalized resistance to insects feeding on plant parts having the highest concentrations of endophytic fungi or their associated toxins.

In addition to the observed resistance to predation by insects, plants hosting the endophytic fungus have displayed a certain enhanced performance which includes improved ecological fitness, a more attractive appearance, increased vigor, reduced weed invasion, more rapid recovery from injury, improved persistence, increased density, and apparently greater stress tolerance. For example, in turf trials of tall fescue and perennial ryegrass varieties and single-plant progenies established during the late summer of 1976 at North Brunswick, New Jersey, those varieties containing a high level of endophytic fungus showed dramatically improved performance after seven years. Species tested included tall fescue (Festuca arundinacea) and ryegrass (Lolium perenne). These plants were more persistent, showed reduced crabgrass invasion, produced a higher yield, had greater vigor, and displayed an improved appearance. Much of this improved performance of these fungal-endophyte-hosting plants appears to be associated with improved stress tolerance, such as tolerance of heat, drought and defoliation. Similar enhanced performance, including resistance to the billbug and the chinch bug, has been observed for hard fescue and for chewings fescue.

The particular endophytic fungus involved in the above described insect resistance and enhanced performance in ryegrass has been provisionally designated the Lolium endophyte. A similar or identical endophyte fungus present within tall fescue has been identified as Epichloe typhina and was recently renamed Acremonium coenophialum.

The life cycles of endophytic fungi have been studied in detail. The fungus begins within the seed of the host plant, adjacent to the aleurone layer. When the seed germinates, the fungus spreads into the developing seedling. Apparently, as the seedling develops, the fungus grows into the rhizomes, leaf tissue, flower stem and seeds, but avoids penetration into the roots.

As a prelude to the invasion of the fungus into its host's developing seed, the fungus concentrates its mycelia in the flower stem. As the seed developes, the fungus grows into the seed adjacent to the aleurone layer, initially avoiding the embryo. Upon germination, invasion of the seedling begins, and the fungus life cycle continues as just described. When seeds are harvested and then stored for later use, care must be taken to store them under cold, dry conditions. Long-term storage (18 months or more) of fungal endophyte-infected seed stored under normal storage practices is known to give rise to plants free of endophyte; this is due to lost viability of the fungal endophyte.

Endophyte levels in selected seed lots of ryegrass varieties are listed as follows:

HIGH		
Repell (GT-II)		
Citation II		
Regal		
Pennant		
MODERATELY HIGH		
Omega II	**LOW**	
Cowboy		
Prelude	Manhattan II	
All*Star	Blazer	
Premier	Fiesta	
	Gator	
	Tara	
MODERATE	Manhattan	
	Elka	
Palmer	Citation	
Derby	Ranger	
Dasher	Omega	
Pennfine	Diplomat	
Delray	Yorktown II	
Linn		

Preemergence Turfgrass Herbicides -- An Update

M. E. Kageyama
O. M. Scott and Sons Company

Introduction

The preemergence control of certain annual weeds in turf, especially grasses such as crabgrass, goosegrass, and foxtail, has grown over the years to become a standard management practice for many professional turfgrass managers. This review is intended to summarize the changes occuring in the preemergence turfgrass herbicide market and to provide information that should be helpful in better understanding the products available and how to make optimal use of these materials.

Preemergence Herbicide Products

Up until recently, the professional turfgrass manager has had a stable number of established chemicals to select from for use in his preemergence weed control program. Bensulide (Betasan), DCPA (Dacthal), benefin (Balan), and siduron (Tupersan) have been programmed for many years for the selective control of crabgrass and other annual grassy weeds in turf. Of a more special use are atrazine for St. Augustinegrass and certain other warm season species and calcium arsenate (Turf-Cal) for *Poa annua* control.

During the 1980's, a broader range of chemicals has been introduced to the market. These include oxadiazon (Ronstar), oryzalin (Surflan), napropamide (Devrinol), and pendimethalin (Turf Weedgrass Control, Southern Weedgrass Control). Along with the introduction of these new active ingredients, the market has experienced an increase in the number of products containing a combination of two herbicides to provide better weed control activity and/or broader turfgrass usage. These include products from Regal Chemical Company (benefin + oxadiazon), O. M. Scott and Sons Company (Goosegrass/Crabgrass Control -- bensulide + oxadiazon), and Elanco (XL -- benefin + oryzalin; Team -- benefin + triflurelin).

Turfgrass Safety

Of the older standard preemergence herbicide products good safety to the major cool and warm season turfgrass species is obtainable with just a few exceptions. For example, with repeated usage, benefin and DCPA can thin fine fescue stands and neither is recommended on bentgrass turf. Also, siduron is not recommended for use on bermudagrass and St. Augustinegrass and on certain cultivars of bentgrass.

Other than oxadiazon and pendimethalin, there is less flexibility with the newer compounds in its use on a broad range of grasses. Oryzalin (Surflan) is recommended for use only on bermudagrass, and napropamide can be used only on tall fescue, bermudagrass, and St. Augustinegrass. None of the new chemicals are labelled for use on bentgrass.

Table 1 highlights the utility of the standard preemergence compounds across a range of cool and warm season grass species.

Annual Grassy Weed Control

The major strength of the established preemergence herbicide products has been its activity on crabgrass. None provide a consistently high level of control of other annual grasses such as foxtail, goosegrass, and Poa annua. The newer compounds oxadiazon, napropamide, oryzalin, and pendimethalin show greater activity on the commonly encountered grassy weed species in turf. This is especially true with oxadiazon on goosegrass and with oryzalin and pendimethalin on crabgrass, goosegrass, and foxtail.

The activity of benefin, bensulide, DCPA, siduron, oxadiazon, napropamide, oryzalin, and pendimethalin on four annual grassy weeds is summarized in Table 2.

Annual Broadleaf Weed Control

The older preemergence herbicides have generally not been used broadly for annual dicot weed control with the exception of DCPA for spurge and creeping speedwell. The new pendimethalin products now offer the opportunity to approach the control of certain problem summer and winter annual dicot weeds from a preemergence standpoint. This includes the control of species such as oxalis, spurge, chickweed, henbit, cudweed, hop clover, and evening primrose. With further field testing and user experience, the full potential of pendimethalin and the other new preemergence chemicals for annual broadleaf weed control will be better understood.

Table 3 summarizes the level of control provided by the currently available turfgrass preemergence herbicides on oxalis, spurge, chickweed, and henbit.

Summary

The proper selection of a preemergence herbicide product for the turfgrass manager today appears to be more complex because of the broader range of chemical choices available; however, the increased flexibility and improved overall performance now attainable with these products presents a positive opportunity to the user. Identifying the specific objectives of his preemergence weed control program, defining the limitations of the site such as grass type, required timing of application, length of the growing season, etc., and understanding the characteristics of each herbicide product now allows the user to develop a program with the potential of providing a meaningfully higher level of performance than was achievable in the past.

Table 1. Safety ratings on seven turfgrass species treated with commercial preemergence turfgrass herbicides

	KB	PR	FF	BG	TF	St. Aug.	Berm.
benfin	S	S	P	NR	S	S	S
bensulide	S	S	S	S	S	S	S
DCPA	S	S	P	NR	S	S	S
siduron	S	S	S	P	S	NR	NR
oxadiazon	S	S	NR	NR	S	S	S
napropamide	NR	NR	NR	NR	S	S	S
oryzalin	NR	NR	NR	NR	NR	NR	S
pendimethalin	S	S	S	NR	S	S	S

. KB = Kentucky bluegrass, PR = perennial ryegrass, FF = fine fescue, BG = bentgrass, TF = tall fescue, St. Aug. = St. Augustinegrass, Berm. = bermudagrass

. S = safe, P = potential thinning, NR = not registered

Table 2. Annual grassy weed control ratings for eight commerical preemergence turfgrass herbicides

	Crabgrass	Goosegrass	Foxtail	Poa annua
benefin	M	M	M	M
bensulide	H	L	L	M
DCPA	H	L	M	M
siduron	M	L	L	L
oxadiazon	M	H	NR	M
napropamide	M	M	NR	M
oryzalin	H	H	H	M
pendimethalin	H	H	H	M

H = High level of control

M = Medium level of control

L = Low level of control

NR = Not registered

Table 3. Annual broadleaf weed control ratings for eight commercial preemergence turfgrass herbicides

	Oxalis	Spurge	Henbit	Chickweed
benefin	NR	NR	NR	NR
bensulide	NR	NR	M	NR
DCPA	NR	M	NR	H
siduron	NR	NR	NR	NR
oxadiazon	M	NR	NR	NR
napropamide	NR	NR	NR	NR
oryzalin	NR	NR	NR	NR
pendimethalin	H	M	H	H

H = High level of control

M = Medium to low level of control

NR = Not registered

Pesticide Storage and Disposal Regulations

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Pesticides must be handled and stored properly to protect the user, nearby people, the environment, and the activity of the chemicals. The storage and disposal of excess pesticides and empty containers are also important factors related to pesticide usage.

Pesticide Storage Regulations for North Carolina became effective January 1, 1984. The regulations apply to all existing and future pesticide storage facilities of chemical manufacturers, commercial companies, pesticide applicators (private, commercial, and public) and homeowners.

The following rules apply to the storage of any quantity of all pesticides from household storage of general-use pesticides to commercial storage of large quantities of restricted-use pesticides.

a. Pesticides shall be stored to prevent leaking and to facilitate inspection.

b. Formulated pesticides shall not be stored in unlabelled containers. The common name, percentage of active ingredient, EPA registration number, signal word, and use classification shall be shown clearly and prominently on any containers. Pesticide products labelled in accordance with the Pesticide Laws of North Carolina shall be deemed to have met these requirements.

c. Pesticides shall not be stored in any food, feed, beverage or medicine container that has previously been used or designed for such purposes.

d. Pesticides shall not be stored in a manner that could cause contamination of foods, feeds, beverages, eating utensils, tobacco, tobacco products, or otherwise likely to result in accidental ingestion by humans or domestic animals. Pesticides should not be stored in commercial storage facilities in such a manner that could cause contamination of other pesticides, seeds or fertilizer.

e. Pesticides shall be stored according to the label directions and labelling of all other products held in the same storage area.

f. Pesticides shall be stored to prevent unauthorized access when unattended.

g. Pesticides shall be stored in an area that is dry and ventilated.

h. Pesticide storage area shall be free of combustible materials such as gasoline, kerosene, or petroleum solvents other than those associated with pesticide application and debris such as waste paper, rags or used cardboard boxes which may provide an ignition source. Pesticides shall be stored away from other operations which present a fire hazard such as welding or burning. Appropriate care shall be taken to minimize fire hazard potential when providing supplemental heat to storage areas during winter months.

Additional regulations apply to the storage of any quantity of restricted-use pesticides in commercial storage facilities prior to possession by the end user. These regulations are also recommended for anyone storing large quantities of pesticides such as golf courses, lawn care companies, and public agencies.

a. Storage areas shall utilize security precautions that prevent unauthorized access to pesticides. Non-display pesticide storage areas shall be locked when unattended and a warning sign shall be posted beside all entrances to non-display storage areas. The sign shall state "PESTICIDE STORAGE", "AUTHORIZED PERSONNEL ONLY", "IN CASE OF EMERGENCY CALL" (Name and/or telephone number of contact person).

b. Pesticide spills shall be cleaned up immediately with regard to personnel safety. Suitable materials shall be kept on hand to absorb spills or leaks and pesticide contaminated absorptive materials shall be disposed of safely.

c. Pesticides shall be stored to prevent contact with water from any source.

d. Pesticides shall not be stored within 100 ft. horizontally of a public water supply or within 50 ft. horizontally of a private water supply.

e. The person responsible for each pesticide storage facility shall be responsible for: (1) compliance with all appropriate state and local fire codes, building codes and all applicable state environmental laws and regulations, and (2) development of a prefire plan for the storage facility and have a copy of the plan for the storage facility and have a copy of the plan that is approved by the fire department or emergency services office in the storage facility office and a copy filed with the local fire department or emergency services office. At least one annual inspection by that office must be requested.

f. The person responsible for the storage facility shall upon discovery of a pesticide emergency notify the North Carolina Pesticide Board, the appropriate local emergency services offices or other agencies requesting such notification.

g. Any person operating a commercial storage facility shall maintain a current (updated every 30 days) inventory list of pesticides and maintain it in a separate location from the storage facility.

Large commercial storage facilities and commercial applicators that store 10,000 lbs. or more of restricted use pesticides at any time shall not store pesticides within 200 feet of the property line of any schools, hospitals, nursing homes, or other institutional facilities and must submit a Contingency Plan in case of an emergency to the North Carolina Pesticide Board for approval. Persons with Pesticide Dealers licenses should become familiar with these contingency plan regulations.

These regulations outline the basic requirements for the safe storage of pesticides. More details on the Regulation 2 NCAC 9L-1901-1913 Pesticide Storage can be obtained from the North Carolina Department of Agriculture. Details on proper pesticide storage facilities and ventilation requirements are also available.

The safe disposal of pesticides and used pesticide containers is another important area of pesticide safety. Excess pesticides can best be disposed of by using as directed on the label by a qualified applicator. If this is not possible, call the Pesticide Disposal Committee of the North Carolina Pesticide Board (919/733-3556) for assistance in helping you to arrange for proper disposal. Some possibilities are to use an approved sanitary landfill, have a

commercial waste disposal company collect the pesticides, or ask the manufacturer to collect the excess pesticides.

The disposal of empty pesticide containers depends on the type of container and label directions for disposal. Liquid containers should be drained for 30 seconds after emptying into the pesticide spray tank. Then rinse three times with water or other rinsing agent if designated on the label, by filling 1/5 to 1/4 full, closing and turning container so that all inside surfaces are rinsed. Then empty into the spray tank for 30 seconds after each rinse. Store the empty containers in a safe place (the pesticide storage area) until time of disposal. Do not reuse them as containers for any other purpose. Empty pesticide containers should be disposed of within 30 days since most pesticide storage facilities cannot accomodate many empty containers. Metal or plastic containers can be crushed to take up less space or holes punched in them to avoid reuse. Glass containers can be broken.

Permanent disposal usually involves burying the empty containers in a carefully selected site or in an approved sanitary landfill. Some containers may be returned to the formulator or manufacturer and be reconditioned or recycled. The preparation, burial or return of the container may be specified on the label. Therefore, read and follow the label directions carefully.

Some paper and cardboard packages may be burned if allowed on the label instructions and if not prohibited by local regulations. If burning is allowed, handle the pesticide containers as specified on the label when using the pesticide, burn in isolated areas, and keep out of the smoke. Be sure that the containers have burned completely and do not leave the area until the fire is out. These containers can also be buried in an approved landfill or isolated area if recommended on the label. Wear protective clothing while disposing of pesticide containers if specified on the label.

In addition to directions for use, information on storage and disposal of pesticides and containers is given on the label of many pesticides. Therefore, **READ THE LABEL** carefully and follow directions and comply with the pesticide regulations for storing and disposing of pesticides and empty containers to insure the safe use of pesticides.

TURFGRASS PHYSIOLOGY AND MANAGEMENT RESEARCH UPDATE

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Each year it is a pleasure to briefly review some of the many ongoing research projects in turf physiology and management. Growth retardant studies have continued on tall fescue, bahiagrass and bermudagrass under both low and moderate maintenance conditions. Tall fescue trials have included general evaluations of new compounds, timing relationships between seedhead development and suppression, interactions of retardants and herbicide applications and weedy grass responses to growth retardants. Bahiagrass general evaluations of growth retardants have also been conducted annually since 1980. Additional information concerning the results of these trials can be found in two other articles included in these proceedings. Investigations for 1985 will include timing in relation to seedhead development and herbicide/growth retardant regimes. Fertility influences on growth retardant effectiveness have been previously examined for bahiagrass and tall fescue, while a trial on bermudgrass was conducted during 1984. Another test initiated in 1984 concerned the effect of growth retardants on the stolon growth of warm season turfgrasses.

The performance and survival of warm season turfgrasses through the winter months continues to be investigated. Tifgreen and Tifway bermudagrass are currently being evaluated for ways to enhance the survival of sod transplanted during the off-season while the bermudagrass is dormant. Treatments include potassium fertility, cutting height, plant hormone applications, antitranspirant coatings, overseeding and thickness of sod. This is the first year of a multi-year study. The seasonal fluctuations of the cold tolerance of warm season turfs has been under study for 3 years.

Water stress continues to be a major problem with regard to fine turf performance and water conservation. Syringing studies for 1985 will concentrate on the effects of this practice on plant water status. This research will seek to determine how syringing can be used for the prevention or relief of wilt. Previous syringing studies have examined the potential of this procedure for cooling golf greens during the summer. Additional water stress projects include treatment of localized dry spots and wetting agent effectiveness.

Many of the projects noted above and others will be highlighted at the annual North Carolina Turf Field Day to be held on Wednesday, May 22, 1985. It is a pleasure to acknowledge the financial and material program support from the following:

Elanco,	Monsanto,	DuPont,	Lofts,
ISI,	3M,	Stauffer,	O. M. Scotts & Sons,
NCDOT,	FHWA,	Smith Turf & Irr.,	Lesco,
Byrum Seed,	Wyatt Quarles,	Turf Seed,	Pickseed West,
Ciba-Geigy,	Amer. Cyanamid,	Northrup King,	Goltra,
CIL Inc.,	Estech,	Porter Brothers,	Carolinas Golf Assoc.,
United Turf,	American Enka,	Tin Whistles,	Carolina Sod,
Aquatrols,	Pbi/Gordon,	BASF.	

Turf physiology and management research projects are conducted with the assistance of three departments and many university personnel including the following technicians: David Beard, Walter Davis, Mike Newnam, Les Privette, Darrell Sapp and Leon Warren; and the following graduate students: Diane Harper, Bill Rose and Derek Smith. Finally, many research projects are conducted away from the NCSU turf plots with the cooperation of many individuals including: Mr. Harrison Cambell, Mr. Al Wooten, Mr. Harley Blackwell and the personnel of the NCDOT Landscpe Unit.

The assistance of all those listed above and any inadverdently omitted is much appreciated. Such cooperation and support is necessary to continue to provide the answers to may of our turf problems.

ACCLAIM (FENOXAPROP-ETHYL) FOR SMOOTH CRABGRASS AND GOOSEGRASS CONTROL IN TURF

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Acclaim, a selective postemergence grassy weed herbicide, was evaluated for the control of smooth crabgrass and goosegrass in common bermudagrass and Kentucky 31 tall fescue during 1983 and 1984.

In 1983, two applications of Acclaim spaced 7 days apart at a rate of 0.18 lb ai/A per application were more effective than one application for controlling smooth crabgrass, 83% compared to 62%. Acclaim was ineffective in controlling dallisgrass. Two applications of MSMA at 1.5 lb ai/A per application or Sencor (metribuzin) at 0.5 lb ai/A per application gave complete control of smooth crabgrass and dallisgrass.

One and two applications of Acclaim gave good to excellent (81 to 97%) control of smooth crabgrass in 1984. The second application was 13 days after the first. The rates per application were 0.25, 0.38, and 0.5 lb ai/A. Goosegrass control for the same rates ranged from 8 to 75% control with two applications being more effective than one. Two applications of MSMA at 1.5 lb ai/A per application only gave 59% control. The test was initiated on June 27 and ratings were taken 5 weeks later. Additional goosegrass germinated following application and before ratings were taken. In the test begun on August 14, the same treatments of Acclaim, except one application at 0.25 lb ai/A, gave excellent control of both smooth crabgrass and goosegrass.

Tests in tall fescue were begun on June 27, July 10, and July 20, 1984. At the first date one application of Acclaim at 0.25 or 0.43 lb ai/A was 20% less effective in controlling smooth crabgrass than two applications which were 93 and 100% respectively. Applications were spaced 10 days apart. One and two applications at 0.5 lb ai/A per application gave 100 and 97% control respectively. On the July 10th date only one application of Acclaim at 0.25 lb ai/A was less effective. All treatments gave excellent control when applied on July 20, 1984.

Tall fescue showed acceptable discoloration from all Acclaim treatments. Color improved from 5 to 30 days after treatment.

In summary, Acclaim provided effective postemergence control of smooth crabgrass and goosegrass with two applications at 0.25 lb ai/A per application spaced 10 days apart or one application at 0.38 lb ai/A. Tall fescue displayed acceptable tolerance to Acclaim while bermudagrass did not.

NCSU Turf Disease Update

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Fungicides were evaluated for the control of dollar spot on bentgrass and red thread on bluegrass and nematicides were evaluated on common bermudagrass in 1984. Results on dollar spot and nematode control are discussed.

The experiment on red thread on bluegrass was established in the mountains but did not yield useful data because the weather became very dry after the fungicides were applied and disease did not continue developing.

Two dollar spot control tests were conducted on bentgrass at the NCSU Turf Research Plots. Fungicides listed in Table 1 were applied on May 30, 1984 to 25 ft^2 plots with a compressed air sprayer. About 10-15% surface area of the bentgrass was affected with dollar spot at the time of treatment. The turf quality and percent area with disease were evaluated on June 13 and June 21. All fungicide applications resulted in significantly better turf quality and lower percent area with disease than the check on both dates. Daconil 2787 gave the lowest turf quality after 2 weeks and Daconil 2787 and Rubigan were the lowest after 3 weeks. Similar results were observed in percent area with disease after 3 weeks. Tersan 1991, RH 3866, Chipco 26019, Bayleton, Vorlan, Banner and Banner plus Daconil 2787 resulted in significantly less disease 3 weeks after treatment than the Daconil 2787 or Rubigan. This long period of control under ideal conditions is a very rigorous test for these chemicals. Several of these chemicals are not expected to give control for 3 weeks, but it is a good indication of their effectiveness. Frequency of application is an important factor in selecting fungicides for controlling dollar spot.

Another test was established to evaluate the effects of the dye, Blazon, on disease control with Daconil 2787, Rubigan, and Chipco 26019. One gallon and 1 quart (the recommended rate) per acre rates of Blazon were mixed with the fungicides before spraying as indicated in Table 2. Turf quality ratings on June 21 were not significantly different between any fungicide, fungicide plus dye, or dye alone treatments, but were better than the no dye treatment. However, percent area with disease ratings on June 13 were significantly lower with fungicides than with the dye alone and there was more disease with no dye.

These results probably indicate that the dye alone does not control dollar spot, but that the evaluation of disease visually is more difficult because of the blue color that remains on dead leaves. A positive effect of the dye on disease control with Rubigan is indicated on both dates with both rates of dye and also on Daconil 2787 with the lower rate of dye. The result with the 1 gallon per acre rate of Daconil 2787 is different from 1983 results in which a negative effect was indicated on disease control. The dye did not affect the results with Chipco 26019 as in 1983. More research is needed to evaluate these effects on Rubigan and Daconil 2787 before the Blazon dye can be recommended or not recommended for use with certain fungicides. Meanwhile, the dye can be used as a spray marker and will probably help cover up some disease symptoms.

Nematicides were evaluated on a common bermudagrass fairway that was infested with sting nematodes. Nematicides and rates indicates in Table 3 were applied with a drop spreader to 100 ft^2 plots on July 5, 1984. The chemicals were watered-in immediately after application with one-half inch of water. Turf quality ratings and/or nematode counts were made on July 5, July 20, and August 9. The objective of evaluating Nemacur and Mocap at 1/2 rates was to determine if these lower rates of nematicides that are labelled on turf would give acceptable quality responses. These lower rates would be more economical to use on fairways as replacement for Soilbrom 90 that is no longer available.

The 1/2 rate of Nemacur gave very good turf quality ratings after two months that were not significantly different from the higher rate. The ratings with both rates of Mocap were significantly lower than the Nemacur and other nematicides after two months. The nematicides that are not labelled on turfgrasses - Counter, Lance and Furadan - gave very good turf quality ratings. It is unlikely that these new nematicides will be labelled for use on turfgrasses any time soon. Sting nematodes counts on August 9 were low or 0 for all treatments. The reason for these low counts, even in the control plots, is not known but may have been due to the very dry and hot weather during the test.

The nematicide results suggest that Nemacur at the 1/2 rate would help improve turf in areas that are infested with sting nematodes. The higher recommended rates should be used on tees and greens whenever needed.

Additional tests are planned for 1985 on dollar spot, red thread, and nematode control with some of these and some new chemicals. These results are from tests in a single year. Several years of results are usually needed before general trends are noted. Financial support from the Carolinas Golf Course Superintendents Association and chemical companies helped support these evaluations.

Table 1. Dollar spot control on Bentgrass.

Treatment and rate/1000 ft^2		Turf Quality* Jun 13	Turf Quality* Jul 21	Disease % Jun 13	Disease % Jun 21
Control		3.0**D	3.0 D	50.0 A	56.3 A
Banner 1.1E	2 oz	8.8 A	8.5 AB	.3 C	.5 C
Banner + Daconil 2787 60WP	3 oz	8.5 AB	8.3 AB	.3 C	.8 C
Banner + Daconil 2787 60WP	6 oz	8.5 AB	8.5 AB	.3 C	.8 C
Daconil 2787 75W	4 oz	6.8 C	5.0 C	5.3 B	31.3 B
Rubigan 50WP	.4 oz	7.5 ABC	5.0 C	2.8 BC	30.0 B
Vorlan 50WP	2 oz	8.8 A	7.8 AB	.3 C	2.3 C
Bayleton 25WP	1 oz	8.5 AB	7.0 B	1.4 BC	10.3 C
Chipco 26019 50WP	2 oz	8.5 AB	7.3 B	.5 C	4.3 C
RH 3866	8 oz	7.5 BC	8.0 AB	1.5 BC	1.3 C
Tersan 1991 50WP	2 oz	8.8 A	9.0 A	.3 C	0 C

*Turf quality: 1-9 with 9 being best

**Column means followed by a common letter do not differ significantly (p=0.05).

Table 2. Dollar spot on Bentgrass, Blazon Test

Treatment	Turf Quality*		% Disease*	
	Jun 13	Jun 21	Jun 13	Jun 21
Daconil 4 oz	6.8 BC**	5.6 A	12.2 CD	30.0 AB
Daconil 4 oz + dye (1 qt/A)	7.4 ABC	6.4 A	3.6 D	16.0 B
Daconil 4 oz + dye (1 gal/A)	7.0 ABC	5.4 A	11.2 CD	33.0 AB
Rubigan .4 oz	6.0 CD	5.2 A	19.0 BC	36.0 AB
Rubigan .4 oz + dye (1 qt/A)	7.8 AB	6.0 A	2.6 D	22.0 B
Rubigan .4 oz + dye (1 gal/A)	7.8 AB	6.4 A	3.0 D	14.0 B
Chipco 26019 2 oz	8.0 AB	6.8 A	2.0 D	13.4 B
Chipco 26019 2 oz + dye				
(1 qt/A)	7.8 AB	6.2 A	2.2 D	16.0 B
(1 gal/A)	8.4 A	6.6 A	1.4 D	14.0 B
Dye 1 qt/A	4.8 D	5.4 A	31.0 B	32.0 AB
Dye 1 gal/A	5.0 D	5.8 A	29.0 B	27.0 B
No Dye	3.0 E	3.0 B	50.0 A	56.3 A

*Turf quality rated on basis 1-9 with 9=best. % disease was a visual estimate of the % area affected with dollar spot.

**Analyzed using Waller Duncan. Means followed by same letter are not significantly different at P=0.05.

Table 3. Sting nematode control on Bermudagrass.

Treatment and Rate/ 1000 ft^2		Nematode No./500 cc		Turf Quality**	
		Jul 5	Aug 9	Jul 20	Aug 9
Control		22.3* A	2.5 AB	5.3 B	3.5 D
Nemacur 15G	2.67 lb	57.8 A	0 B	7.8 A	8.0 A
Nemacur 15G	1.34 lb	51.8 A	0 B	6.8 A	7.5 AB
Counter 15G	2.5 lb	42.3 A	0 B	7.5 A	8.0 A
Counter 15G	1.25 lb	50.3 A	0 B	7.3 A	7.5 AB
Mocap 10G	4.5 lb	73.8 A	2.8 AB	7.3 A	6.0 C
Mocap 10G	2.25 lb	17.0 A	0 B	7.8 A	6.3 BC
Lance 20G	2.25 lb	60.5 A	0 B	6.8 A	7.5 AB
Furadan 10G	2.67 lb	29.5 A	5.8 A	6.8 A	8.0 A

*Column means followed by a common letter do not differ significantly (P=0.05).

**Turf quality: 1-9 with 9 being best.

TURF EXTENSION UPDATE

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PUBLICATIONS. The 'Turfgrass Pest Management Manual', a guide to the major turfgrass pests and turfgrasses has been released. The publication was partly funded through a grant provided by the Carolinas Golf Association whose purpose is to support worthwhile projects that will benefit the Turfgrass Industry and the users of turf. The 64 page publication containing 90 colored photographs with grass illustrations is divided into six sections:pest management strategies, turfgrass vegetative identification, weeds in turf, diseases, insect pests on turf and soil sampling .

'Carolina Lawns', one of the most popular Extension publications has been revised. The 32 page publication that discusses lawn establishment and care can be obtained at your local extension office. Other publications underway include: 1)Overseeding Bermudagrass Turf; 2) Diseases of Cool Season Grasses; 3)Diseases of Warm Season Grasses and various lawn calendars.

OTHER PROJECTS. Funding was received from the North Carolina Agricultural Foundation to establish a permanent self touring turfgrass management demonstration area located adjacent to the existing NCSU Turfgrass Field Plots. Development should be completed by June 1986. This facility will provide an opportunity to clearly illustrate the benefits of sound agronomic practices and incorporate various themes of management. The layout and turf species within this area will be periodically updated to reflect the latest research developments.

A grant has been received to develop and initiate a volunteer turfgrass scouting program in three counties; Buncombe, Guilford and Wake. An extensive field scouting guide was developed with assistance from Drs. Lewis, Lucas and Robertson. Information sent in by trained scouts are recorded and advisory bulletins, unique to each county, are developed weekly and information made available through Extension teletip.

Keep in mind that all of the projects just mentioned are truly a joint effort from all members of the turf work group at N.C. State University and not the result of one individual.

TURF ENTOMOLOGY UPDATE

James R. Baker
Extension Entomologist

Extension Entomology at North Carolina State University is pleased to announce that Dr. Rick L. Brandenburg has been hired to fill the extension position vacated by the retirement of Prof. Bob Robertson. Rick will be responsible for insect and mite control on peanuts, small grains, alfalfa, forage crops and turf. A native of Indiana, Rick earned his B.S. degree in 1977 at Purdue University. His dissertation at N. C. State University was on spider mites on peanuts. After receiving his Ph.D., Rick worked for four years as a research and extension entomologist at the University of Missouri. Although turf insect management is only a part of his total extension responsibilities, Rick is especially interested in developing a grub management program for commercial sod cultivation and maintenance.

THE TURFGRASS COUNCIL OF NORTH CAROLINA, INC.

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

PURPOSES AND OBJECTIVES

The purposes of the Turgrass 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 N. C. 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 N. C. 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 $20 per year. Sustaining memberships at $50 are also available.

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Make check for $20 payable to Turfgrass Council of N. C. and mail to Turfgrass Council, Box 36160, Raleigh, N. C. 27606

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