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PREFACE

Proceedings of the 24th Annual North Carolina Turfgrass Conference are being provided as a permanent reference to those who attended the conference. The 1986 conference was held at the Benton Convention Center in Winston-Salem, N. C., on January 8, 9 and 10. Sessions with general turf topics and concurrent sessions for golf course, lawn care, roadside and low maintenance turf, landscape maintenance, sod, and athletic field topics were scheduled. Workshops on Establishment and Maintenance of Lawns, Turfgrass Insects, Turfgrass and Weed Identification, and Small Engine Maintenance were held in the afternoon of January 8. The trade show had 112 booths and 50 exhibitors. 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 Piedmont Turfgrass Association. The following committee members contributed to the success of the conference.

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The 1987 North Carolina Turfgrass Conference will be held in Winston-Salem, N. C., on January 9, 10 and 11.

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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TURF MANAGEMENT PROBLEMS - SOURCES AND SOLUTIONS

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No matter where a turf facility is located there always seem to be problems associated with growing good grass. No doubt concerns greatly increase as grounds managers push to achieve "perfect" turf for a site. Consequently, one of the first orders of business for a grounds superintendent is to determine the difference between perfect and necessary turf. The quality requirements of turf on a championship golf course or a football stadium viewed by millions are great. On a small 9 hole public golf course or a soccer field used 10 hours a day, 7 days a week expectations are less, but because of limited resources the job may be more difficult. Directing available resources to get the most out of them is a primary duty of a grounds superintendent.

Certainly, the best turf possible for any facility should be sought. Management must take the most effective approach in solving problems that prevent the production of good turf. Continuous stopgap efforts to solve permanent, ongoing turf growing problems seldom give satisfactory results.

Unfortunately turf problems seldom originate from single sources, and seldom will one action solve them. In recent years, a great deal of attention has been given to integrated pest management (IPM) programs. IPM means that a multiple management approach should be followed to solve pest problems. A similar approach-analyze the problem and formulate a broad base solution - is appropriate for handling turf problems.

Below, a few of the most common sources and solutions of turfgrass problems are discussed. This can serve as a starting point in assessing and correcting some common turf growing problems.

Climate and weather. Climate is a generalization of weather conditions over a period of time. Considering the average temperature and precipitation in North Carolina the climate could be considered moderate with cool, humid conditions in the west, and warm and humid conditions in the east (Table 1). Weather refers to atmospheric conditions at a specific time and place. Extensive information on climate and weather is available for large and small cities and communities, and this should be utilized in solving and avoiding turf growing problems.

Table 1. Yearly approximations of climatic and weather data for 3 locations in North Carolina.

Location	Temperature = °F Minimum Ave.	Minimum Ext.*	Maximum Ave.	Maximum Ext.	Precipitation -In. Yearly Total	Ave. Frost Free Days
Asheville (Western)	46	-2	67	99	37	195
Raleigh (Piedmont)	49	7	71	105	45	238
Wilmington (Coastal Plain)	53	11	74	104	50	262

*Extreme

The length of the frost free season is quite important in deciding the species and cultivar of grass to grow. Because of the 2-3 month shorter frost free period in Western North Carolina, warm season grasses including zoysiagrass (Zoysia japonica) and bermudagrass would be dormant and brown too long for many turf uses. On the other hand, in the Coastal Plains, the long, hot growing season could provide quite acceptable growing conditions for St. Augustinegrass, carpetgrass and bahiagrass. Kentucky bluegrass and fine fescue, cool season grasses, would not be expected to do very well in the Coastal Plains.

Generally warm season turfgrasses in North Carolina are considered to have poor cold tolerance; an exception is Z. japonica. However, in the High Plains and Mountain Valleys of Colorado, buffalograss, blue grama, as well as 'common' bermudagrass, 'Meyer' zoysia and other warm season grasses can be found where temperature extremes reach -30 to -40°F or below. Research (2) at Colorado State University with bermudagrass and seashore paspalum (Table 2) indicated that a wide range in cold temperature hardiness exists between cultivars of bermudagrass, and that seashore paspalum seemed to be as resistant to low temperature kill as 'Tifway' bermudagrass. Since seashore paspalum is so salt tolerant its use will likely be more extensive, and this information will give an indication of just how far north it can be used.

Table 2. Low temperature killing point expressed in °C for cultivars of bermudagrasses (*Cynodon* spp.) and *Paspalum vaginatum*.

Cultivar	Low temperature killing point[z] (°C) Oct 18 1978	Nov 15 1978	Dec 14 1978	Jan 13 1979	Feb 14 1979	Mar 16 1979	Apr 15 1979	May 14 1979
Paspalum vaginatum								
Futurf	-2	-3	-7					
Adalayd	-3	-3	-7					
Cynodon spp.								
Tifway	-3	-4	-7					
La Junta	-2	-4	-9	-9				
Santa Ana	-4	-5	-9	-9				
Pee Dee 102	-2	-5	-11	-11				
Tifdwarf	-3	-5	-11	-11				
Tifgreen	-2	-6	-9	-11				
NEJC	-2	-3	-11	-11	-13			
Brookings	-2	-6	-13	-17	-17	-11	-6	-6

[z]The killing point was considered the midpoint in the inflection curve of the electrolyte loss curve

In the northern continental United States extremely low temperatures occur (>-50°F), often without insulating snow cover. Because of this an extensive study (1) of the cold hardiness of commonly grown turfgrasses was done at Colorado State University. Of the 9 species studied, the 11 cultivars of perennial ryegrass were the least tolerant to low temperatures, and creeping bentgrass was the most cold hardy. The LT_{50} lowest test temperature at which 50% or more of the crowns survived) for perennial ryegrasses ranged from -5°C (23°F) for 'common' to -15°C (5°F) for 'Manhattan' and 'Diplomat', and for 7 cultivars of Kentucky bluegrass the LT_{50} ranged from -21°C (-6°F) for 'Merion' to -30°C (-22°F) for 'Windsor'. 'Emerald', 'Penncross', and 'Penneagle' creeping bentgrasses had an LT_{50} of -35°C (-31°F). The fact that soils moderate temperatures greatly helps explain why grasses take much lower air (reported) temperatures than these. Regardless, this information helps explain why 'common' perennial ryegrasses could be considered, in many situations, to be nurse grasses going out of permanent (Kentucky bluegrass and fine fescue) turfgrass stands because of cold stress.

Rarely can significant temperature changes be made to help solve turf problems. The cost of electric heat or continuous covering and uncovering turf with a polyethylene sheet is great, and these practices need to be closely monitored to avoid problems that they can cause. However, artificially supplying precipitation (irrigation) is a common and fairly inexpensive practice that can cause or solve turf problems.

In arid and semi-arid regions, too much or too little water is the number one cause of poor turf quality. This problem is often accentuated when only poor quality water is available. In more humid areas, the same is likely true, since turf managers have no control over natural precipitation. Because of the erratic nature of rainfall on unirrigated turf, there are extended drought periods, and where turf is irrigated there is a tendency to over water. Over watering restricts root development and creates a less drought resistance turf. Also, over watering tends to increase annual bluegrass and crabgrass problems, making stands more difficult to manage.

Much more attention needs to be given to water management by grounds superintendents. Unfortunately, until recently most turf water management research was done in dry areas in the western U.S. Findings of this work may not relate closely to more humid areas since grasses in arid and semi-arid regions can be managed to get the most out of water.

The drought tolerance of different turfgrass species and cultivars vary greatly. In North Carolina, the adaptation of tall fescue to droughty conditions would usually be considered quite good, with Kentucky bluegrass being considered only fair to good. In Colorado the adaptations could be reversed, for there is seldom significant subsoil moisture for the deep roots of tall fescue to extract, and the water use (evapotranspiration) from a tall fescue turf is greater than for Kentucky bluegrass. Also, soil protected rhizomes of sod forming Kentucky

bluegrass are able to regrow and spread rapidly when adequate moisture is available. A poor stand of Kentucky bluegrass can rapidly recover from extended drought stress, while tall fescue will tend to bunch up and remain that way.

Soil conditions. Major problems in turfgrass production result from poor soil conditions. It is sometimes difficult to separate water and soil problems. In Colorado, because of rapid population growth, turf is often established on very poor soils. Infertile soils are common for turf sites. Although they are fairly expensive, turf fertility programs can be developed to meet most turf needs. Soil tests are too often talked about and too little used in developing economical turf fertility programs. The same could be said for adjusting the soil pH with lime, or acidifying alkaline soils. Soluble salts frequently cause turf growing problems along highways that are deiced with salt, in arid and semi-arid regions, and where seawater intrudes into turf areas or irrigation water. In North Carolina there will be some turf salt problems, but they will not be nearly as common as in Colorado.

Soil physical conditions are usually quite expensive and difficult to significantly alter. Too little attention is given to saving and reusing good topsoils for turf production. Frequently the soil that ends up on top is inverted subsoil, or was heavy clay soil brought in from another site. Of course the heavier a soil is, the more it compacts, and the shallower the turf roots will be. Managing heavy soils requires good drainage, especially surface drainage.

Improving heavy soils with organic matter for new lawns has been regulated by a municipality in Colorado. Since people are less likely to get into trouble with organic amendments than with other materials, including sand, this seems reasonable. Sand mixed with heavy clay soils has produced adobes that are next to impossible to manage. Organic materials are extremely variable, and commercial native peats in Colorado run from around 20 to 75% organic matter. In one instance an 80% sand + 20% peat mix had an infiltration rate of about .03 inch/hour. This is not adequate for a golf green in a semi-arid region, let alone in a humid one. Other instances have seen feed lot manure - in dry areas these can be very high in salts - used as organic amendments. The manure may cause salt levels to become too high to grow many grasses.

Pest problems. Of course, the severity of disease, insect and weed problems relates to environmental conditions. If bentgrasses and perennial ryegrasses are to be grown in hot, humid areas, growing conditions need to be made as near ideal as possible. Adequate drainage and air movement need to be provided for the turf, otherwise Pythium blight and brown patch will continually occur, and chemicals will be needed routinely to maintain a stand. Unless soil fertility is adequate to maintain a competitive stand of turfgrass, weeds will be a constant problem.

Management problems. Some of the most embarrassing problems on turf facilities are those caused by the manager. Spilled fertilizer resulting in burned turf, watering problems caused by broken heads, and use of soil sterilants where something less persistent and leachable would have been better are but a few of many problems caused by turf managers. With just a few changes in management practices these can be avoided.

Managing turf to minimize problems requires that grounds superintendents continually seek practical solutions. In some instances the problem may be simply solved by mowing higher or replacing an irrigation head. In others, it may require extensive underground drainage installations or even rebuilding intensely used turf areas. The proper approach is to seek permanent solutions to problems. Causes of turf problems are seldom very obvious or easy to change.

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HOW MANAGEMENT PRACTICES AFFECT TURFGRASS DISEASES

Houston B. Couch(1)

Rates of fertilization, watering practices, mowing heights, and amount of thatch are known to have significant effects on the incidence and severity of certain turfgrass diseases.

Fertilization.-

Of the various nutrient elements, calcium and nitrogen appear to have the most profound influence on disease development. Pythium blight (incited by P. ultimum and P. aphanidermatum), Rhizoctonia blight (incited by R. solani), and Fusarium blight (incited by F. culmorum and F. poae) are more severe under low calcium nutrition.

The incidence of rust (incited by Puccinia coronata) on perennial ryegrass is significantly lower under high nitrogen fertilization. Plants receiving high nitrogen fertilization have been shown to have 50 percent less rust than those growing under low nitrogen nutrition. The severity of Corticium red thread (incited by Laetisaria fuciformis) is much less when the plants are growing at high soil nitrogen levels. However, the susceptibility of turfgrsses to Rhizoctonia blight, Pythium blight, Fusarium blight (incited by F. culmorum and F. poae), and the Helminthosporium-incited leaf, root and crown diseases (incited by various species of Drechslera and Bipolaris) is greatest when high rates of nitrogen fertilization are used.

Soil Moisture.-

When soil moisture stress increases, significant changes in the physiology of turfgrass plants occur. These include alterations in cell turgor, changes in transpiration rates, reductions in chlorophyll content, and lowered amounts of sugars, carbohydrates, amino acids and proteins in the leaves, roots and crowns. As the result, when the availability of soil moisture is reduced, there can be a significant alteration in the ability turfgrass plants to withstand infection and colonization by parasitic fungi.

The susceptibility of Kentucky bluegrass to Sclerotinia dollar spot (incited by S. homoeocarpa) is much greater when the plants are growing at soil moisture levels close to the wilting point. Also, Pythium blight and Fusarium blight are more severe when the soil moisture content is low. Rhizoctonia blight and Corticium red thread, on the other hand, do not appear to be affected by soil moisture stress.

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Mowing Height.-

Where mowing height is concerned, Kentucky bluegrass cut at 1 1/2 inches is more resistant to Helminthosporium leaf spot (incited by Bipolaris sorokiniana) than when the plants are cut to 2 inches. Bacterial wilt of 'Toronto C-15' bentgrass is more severe on greens mowed at 2/16 inch vs. greens with a cutting height of 3/16 inch.

Thatch.-

A heavy accumulation of thatch can create stress conditons that have direct, detrimental effects on the growth and development of turfgrass plants. Also, since thatch serves as a growth medium for many fungi that are pathogenic to turfgrass, large amounts of this material can mean larger quantities of fungus propagules that are capable of inciting disease.

The changes in the physiology of the plants and the increases in levels of inoculum that are brought on by heavy thatch are known to affect the development of certain turfgrass diseases. The incidence and severity of Helminthosporium leaf spot, Fusarium blight and Pythium blight have all been shown to be greater when the plants are growing under conditions of heavy thatch accumulation.

Conclusions.-

Changes in management practices can impact directly on the overall health of a stand of grass. Although the complete control of turfgrass diseases cannot be brought about by changing the fertilization, watering or mowing practices, these activities are an important factor in deciding which type of fungicide to use, and in determining what the time intervals should be between fungicide applications.

In other words, the degree of effectiveness of a given fungicide in the control a disease is more than an expression of the amount of active ingredient applied within a specified time period. Instead, it is a function of the effectiveness of the compound within the range of disease incidence and severity that has been established by the combination of management practices and the prevailing weather conditions.

This means that when changes in such management practices as fertilization rates, mowing heights, and watering patterns are being considered, there should also be an evaluation as to whether or not the new program will either require a change to new types of fungicides, or if it will be necessary to change the rates and frequency of applications of the fungicides that are presently being used.

WATER MANAGEMENT ON COMPACTED SOILS

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Foot and vehicular traffic on recreational turfgrass sites often result in soil compaction - the pressing together of soil particles resulting in a more dense soil and less favorable growth medium. Soil compaction has a major influence on turfgrass water relationships. In fact, many of the injuries enhanced by compaction are water related - either from water deficits (wilt, desiccation, winter desiccation) or excess water (scald, intracellular injury).

Before we discuss cultural practices to reduce compaction effects, it is important to understand exactly how soil compaction affects turfgrass water relations. Since the most common form of soil compaction on recreational turf is compaction of the upper 1 to 3 inches, that will be the focus of this article. Other types of soil compaction also occur and present unique problems and cultural approaches to resolve them. For example, a thick compacted zone of 3 to 12 inches near the surface (as occurs from a heavy clay topsoil where equipment runs over the area during construction) presents different problems than a compacted zone of 1 to 3 inches thick that occurs several inches deep in the soil profile (i.e. a plow pan situation).

SOIL RESPONSES

As the upper 1 to 3 inches becomes compacted, the total pore space decreases and fewer large pores (macropores) remain. Macropores are important for rapid drainage, gaseous movement into and out of the soil, and root channels. More specifically, the following soil physical properties are altered.

1). Infiltration decline. With only a few larger pores at the surface, water does not enter the soil as rapidly. This makes good irrigation scheduling difficult, especially during hot, dry weather. In periods of high precipitation, water collects in low spots or runs off the site.

2). Soil aeration decreases. Turfgrass roots cannot efficiently absorb water if soil O_2 is low. Since compaction reduces the volume of large pores that would contain O_2, the O_2 level declines for long periods after saturation by rainfall or irrigation events. The net result is poor root growth, root dieback in severe cases, low root viability, and poor water uptake.

3). Soil strength increases. With fewer large pores, the roots must exert more energy to penetrate the small pore spaces. Also, a dense soil exhibits greater total adhesive and cohesive forces holding the soil particles together, especially as the soil dries. The lack of root channels and a hard soil slow the rate of root extension and cause a shallower root system to develop which limits water uptake.

4). Moisture retention capabilities of the soil are altered. The greater number of small pores (micropores) result in more total water retention but the water is often held too tightly by soil particles for plant use. Thus, a compacted soil often has less available water for plants compared to the same soil that is not compacted, especially for loams and clay soils.

5). Soil temperatures can be altered. In the spring, compacted soils are usually colder due to their higher total water content. This delays root initiation and slows root growth. During the summer, compacted soils are often warmer due to less turf cover. Drier, compacted soils transmit heat more rapidly than an uncompacted soil. Higher soil temperatures can result in root death, especially on cool-season species.

PLANT RESPONSES

The less favorable soil physical conditions of a compacted soil soon result in adverse effects on the plant. Plant responses that directly influence water use are;

1.) Root growth. Compaction influences root characteristics in several ways.

a) Reduced depth and extent of the root system. Deep rooting is important during dry periods. Without deep roots, the grower is forced to irrigate lightly and more frequently.

b) Root viability and longevity may decline. Low soil O_2 can reduce the permeability of the root cells to water movement and result in cell death if the O_2 stress is prolonged.

c) Root tips can increase in diameter due to the hard soil and further reduce penetration into the soil.

d) Root hairs may be fewer in number. Evidence for this is limited but a reduction in root hairs would greatly reduce total root water absorption.

e) Root porosity increases. Under low soil O_2 root porosity increases, especially if the roots are subjected to wetting and drying cycles. A high root pore space (these root pores allow O_2 movement inside the root) develops from adventitious (secondary) root development in the upper 1 to 2 inches or from breakdown of cell tissues. Oxygen moves from the atmosphere into the root and alleviates the O_2 stress; thereby, increasing the ability of the plant to extract water under low soil O_2 levels.

The net effect of these root responses is to limit the volume of soil for water uptake and to reduce the ability of the root to take up moisture during wet soil conditions. Thus, whether the soil moisture status is wet or dry, compaction reduces water uptake. The beneficial response of greater root porosity aids in increased water uptake but only to a limited extent under very low soil O_2 (i.e. saturated) conditions.

2.) Shoot morphological responses. A number of shoot morphological (structural) changes occur under compaction that influence water use of the plant. These include;

a) Decreased shoot density. Turfgrasses produce fewer tillers, rhizomes, and stolons under adverse growing conditions. This results in less total leaf area for transpirational water loss. However, with greater solar radiation reaching the soil surface, evaporational losses from the soil surface may increase. This could be a substantial loss of water if the grower is irrigating frequently.

b) Rate of leaf extension is reduced. The leaves grow at a slower rate and this reduces the amount of leaf area that could result in water loss.

c) Stomatal numbers may decrease. Since transpiration occurs through the stomata, a reduction in stomatal numbers would reduce water loss (i.e. stomatal resistance increases).

d) The actual structure (leaf numbers and leaf orientation) is altered with a more open canopy. This would imply that canopy resistance to water loss into the environment would be less. Thus, water should be lost more rapidly, especially by evaporation.

The total effect of these morphological responses is to reduce water use (i.e. water needs) of the turf plant grown under compaction. However, if a grower is applying water on a low volume, frequent application basis (in response to low soil infiltration and a limited root system), the reverse can be true - evaporational losses become so high that total water use increases over what an uncompacted grass would use. The increased water use results from greater evaporational losses rather than transpiration needs.

3.) Shoot physiological responses. Compaction may result in certain physiological responses that would affect water use, such as;

a) Leaf water potential is lower for grasses grown under compacted conditions. The reason for this response is not clear but this should reduce transpirational water use.

b) Stomatal diffusion resistances are higher, probably due to the lower leaf water potential and fewer stomata. This would decrease transpiration at any particular soil moisture level.

c) Canopy temperatures are 1 to 3°C higher under compaction. The higher temperatures would result from increased stomatal and closure reduced efficiency in soil water uptake by the roots. With higher temperatures, evaporation and transpiration increases.

d) Drought hardiness may decline due to a more succulent turf (if frequently irrigated) and lower total nonstructural carbohydrates. Drought hardiness does not directly influence water use, but is important for plant survival during drought stress periods.

It should be clear that many factors (soil physical properties, root and shoot morphological, and physiological factors) may affect water use of grasses on compacted soils. While the grass plant uses less water under compacted versus uncompacted conditions, the grower often finds it necessary to irrigate with low quantities of water on a frequent basis. This type of irrigation regime greatly increases evaporational losses and, therefore, total water use.

CULTURAL PRACTICES TO IMPROVE WATER MANAGEMENT

If the soil and plant effects of compaction are alleviated or reduced, then the water management problems are improved. Several approaches are possible. The grower should use a combination of cultural practices because no single approach, except total soil modification, will resolve the problem.

1). Use of species/cultivars adapted to your climate, pest stresses, use, and cultural level is important. Compaction makes the turf more susceptible to other stresses and reduces recuperation once injury occurs. By limiting other stresses, soil compaction problems are less frequent.

After the above selection criteria are used, the grower can determine if a particular species or cultivar is more tolerant to compaction than another and use the tolerant grass. Limited information is available on specific compaction tolerance of species and cultivars but the following list summarizes current information;

Cool-Season Grasses	Compaction tolerance
Perennial ryegrasses	Most
Some tall fescues - Brookston, Houndog, Rebel	
Kentucky bluegrasses - Sydsport, Ram I, Touchdown, and Bensun are somewhat more tolerant.	
K-31 tall fescue and other tall fescues	
Creeping bentgrass	
Red/chewings fescues	Least
Warm-Season Grasses	
Bermudagrass	Most
Buffalograss	
Zoysiagrass	
Centipede	
St. Augustine, others	Least

2). Traffic control to minimize compaction is another approach. This may take several forms such as;

*using alternative practice fields
*moving around the total area of a football field during practice
*limiting traffic on a excessively wet field
*limiting band practice on the main field
*using larger greens and tees
*more frequent movement of tee markers and flags on greens
*cart paths
*careful design to prevent excessive traffic areas

3). Cultivation to provide openings for water infiltration, gas exchange, and root channels is a major means of reducing compaction effects. Generally, a program should be developed using one or more cultivation techniques and possible topdressing with sand. Core aeration is especially effective but other methods can be useful - slicing, grooving, spiking, forking, shattercoring, deep core aeration, and sub-aerification.

4). Other management programs should be adjusted to allow for the best growth. For example, high levels of nitrogen (N) on compacted turf can restrict rooting even more than compaction or high N alone. Good surface and subsurface drainage should be developed. A good pest program to control diseases (brown patch, pythium) and weeds (knotweed, goosegrass, Poa annua) that are problems on compacted sites should be formulated. Irrigation scheduling is worth particular attention and every effort should be made to irrigate as deeply and infrequently as possible. Practices to improve soil infiltration and to develop deeper rooting will allow for such an irrigation regime.

The grower should remember that the use of a low volume, frequent irrigation schedule is the primary reason for excessive water use under compacted soil conditions.

5. Chemical soil modification may provide some help in specific situations. Gypsum can assist in promoting a better structure on heavy, salt affected soils. However, remember that even naturally well structured soils succumb to compaction if the traffic is severe enough. Sometimes chemicals have been used to stabilize a soil structure. Examples include polyvinyl alcohols, polyacrylamides, and various algae based polymers. These products stabilize the existing structure but structural units can still break down under compaction. Wetting agents have been used to improve drainage of compacted soils but research evidence for their use is limited and conflicting.

6. Physical soil modification can effectively reduce the potential for compaction. Partial modification by the addition of sand or organic matter to a heavy, clay soil can be useful if the proper porportions and materials are used. Organic matter contents up to 15% are normally used but a total sand content of 85% or more may be more effective. Complete modification is an alternative to partial modification if intensive traffic is expected. The USGA Green Section specifications, the Purr-Wick, and the PAT systems are all effective for golf greens and athletic fields.

7. The paver system is the last approach. Many of these systems have a concrete or plastic matrix to withstand traffic with some openings for grass to grow. For cart paths and parking areas, this can be a good approach. The ultimate "paver" is artificial turf.

Certainly a compacted soil presents a severe challenge to good water management. But if the above cultural approaches are utilized, compaction will be reduced and as a result, water management will improve. Research has demonstrated that a 25 to 50% savings in water use can be achieved with proper management.

THE EFFECT OF NOZZLE PRESSURE, NOZZLE TYPE AND DILUTION RATE ON THE EFFICACY OF TURFGRASS FUNGICIDES

Houston B. Couch(1)

In 1981, a field research program was initiated by the members of the turfgrass pathology laboratory at Virginia Tech to investigate various procedures for making the most effective spray applications of turfgrass fungicides. The individual experiments were designed to determine (i) the optimum amount of water per 1,000 square feet of turf, (ii) the appropriate nozzle types and nozzle tip sizes, and (iii) the most suitable pressure at the nozzles for the control of turfgrass diseases under conditions of 1 1/2 to 2 inch cutting heights and under bowling green and golf course putting green mowing heights. The diseases included in the trials were Sclerotinia dollar spot (incited by S. homoeocarpa), melting-out of Kentucky bluegrass (incited by Drechslera poae), and Rhizoctonia blight (incited by R. solani). The fungicides tested included both contact and systemic materials. The following is a summary of the results of these trials.

Optimum Dilution Rates and Nozzle Tip Sizes.-

One series of experiments tested for the relationship between dilution rates, nozzle orifice size and fungicidal effeciency. Concentration of the various fungicidal treatments ranged from 0.5 to 32 gallons of water per 1,000 square feet of turf.

Only one nozzle type was used in this group of experiments, the Uni-jet flat fan (manufactured by Spraying Systems Co., Wheaton, Ill.) The variables consisted of different spray tip sizes in combination with different water gallonages. In this series, all applications were made at a nozzle pressure of 30 psi. The various dilution rates and corresponding nozzle tip sizes used in these experiments were as follows:

Tip Size	Gallonages
T-800050	0.5, 1.0, 2.0, 4.0
T-8002	0.5, 1.0, 2.0, 4.0
T-8008	4.0, 8.0, 16.0, 32.0

The fungicides included in these tests were Bayleton, Chipco 26019, Banner, Vorlan, Daconil 2787, and Dyrene.

The results of these experiment have shown that with the flat fan nozzle, there is a direct relationship between nozzle tip size, the dilution level and the effectiveness of individual fungicides. Where orifice size is concerned, with each fungicide, optimum disease control was consistently achieved with the

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8002 tip. The dilution levels for maximum disease control for the materials included in these trials were as follows:

Fungicide	Dilution per 1,000 sq. ft.
Daconil 2787	1 gallon
Dyrene	1 - 2 gallons
Bayleton	2 gallons
Chipco 26019	0.5 - 4 gallons
Banner	2 gallons
Vorlan	1 - 2 gallons

Optimum Nozzle Types and Nozzle Pressures.-

Additional experiments have been performed to test the relative effectiveness of certain fungicides when applied with different nozzle types and at varying pressures at the nozzle. The nozzle types included in this series were (i) the Uni-jet flat fan with T-800050, T-8002 and T-8008 tips, (ii) Uni-jet flood jet TK-30, and (iii) the swirl chamber 'Raindrop' RA-15. The individual nozzle pressures for the flat fan nozzles were 10, 30, 60 and 90 p.s.i., while with the flood jet and raindrop nozzles, the pressures at the nozzles were 20, 30, 40 and 55 p.s.i. The fungicides tested in these trials were Bayleton, Chipco 26019, Dyrene, Rubigan, Daconil 2787, and Acti-dione TGF.

With the flat fan nozzle, maximum disease control with all fungicides tested was obtained at 30 - 60 p.s.i. at the nozzle. A significant drop in disease control effectiveness occurred with all fungicides when they were applied at 10 p.s.i. Maximum disease control with the 'Raindrop' swirl chamber nozzle was obtained at 30 p.s.i. at the nozzle. The flood jet nozzle was most effective at 30 - 40 p.s.i. at the nozzle.

Of the three nozzle types, the flat fan T-8002 and the swirl chamber RA-15 gave comparable levels of disease control. The performance of the TK-30 flood jets, however, was significantly inferior to the other two nozzle types.

Conclusions.-

This research has shown that in the use of a boom-type spray system, there are specific dilution rates at which fungicides perform most effeciently. Also, nozzle type can have a significant effect on fungicide performance. Flat fan T-8002 and swirl chamber RA-15 nozzles both provide effective levels of fungicide distribution at 30 p.s.i. at the nozzle. Flood jet TK-30 nozzles do not give levels of disease control comparable to that obtained with flat fan or swirl chamber nozzles.

If the maximum potential of a fungicide is to be realized, it is important that careful consideration be given to the selection of the optimum dilution level, nozzle type and size, and nozzle pressure for its application.

WATER MANAGEMENT ON GOLF COURSES

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The viewpoints of a westerner on water management on golf courses may seem, to eastern superintendents, a bit strange. Proper water management in areas that receive 10-15 inches of precipitation a year, and water costs, excluding pumping, that can exceed $100,000 per year for golf courses is critical. With this in mind, it is easy to see why research on turfgrass water conservation has received so much attention in arid and semi-arid regions.

Research information from arid and semi-arid regions on turfgrass water management has some application limitations in humid areas. Even so, many principals of turf water conservation have application in North Carolina. These could help a golf course superintendent manage a facility with reduced amounts of water. Some of the more important principals relating to water management are briefly discussed below.

Retain good soils, improve poor ones. Too little attention is given to retaining good topsoils on turf sites. Amending heavy soils with organic matter or high percentages of inorganic materials can improve soil physical conditions. Good soils for turfgrass should have good aeration and they should drain well. Deep rooting of turfgrass on good textured soils (for example, sandy loams and loamy sands) allows for water extraction from fairly large soil volumes. The amount of water available for plants on loams is greater than on heavy clays; consequently, less frequent irrigation is usually required on lighter soils.

Use drought tolerant turfgrasses. In many cases, grasses with improved drought tolerance can be used without giving up turf quality. Bermudagrass normally do quite well under dry conditions, while centipedegrass does not. Response to drought stress varies among grasses. Tall fescue and Kentucky bluegrass can recover rapidly from moderate stress - often within a few hours - while buffalograss tends to have leaf tip dieback and be slow to return to good quality. Buffalograss, however, is able to tolerate extended, severe drought in a dormant (brown turf) state.

With soil disturbance, and without irrigation, it can take many years to get satisfactory revegetation on dry sites, even with drought tolerant grasses. In dry areas it is usually advisable to leave native or existing vegetation undisturbed as much as possible.

In arid and semi-arid regions drought tolerant grasses are often used for a major portion of golf courses. Grasses that produce high quality turf with irrigation are used for ball landing areas or for narrow fairways. Overseeding of high water requiring annual bluegrass with perennial ryegrass, which takes much less water, has become a common practice in cooler parts of the U.S.

Time irrigation for maximum benefits. Deficit irrigation can contribute to efficient water use for both warm and cool season turfgrasses. Watering in the summer to supply about 75 to 80% of potential evapotranspiration (ET) will normally provide acceptable turf for cool season grasses. The frequency of irrigation is also important, and can contribute to efficient water utilization by turfgrasses. For example, in Colorado, irrigation of 'Merion' Kentucky bluegrass at 2 and 4 day intervals produced better turf than the same amount of water (50 to 75% of potential ET) applied at 14 day intervals.

Monitor the irrigation system for problems. No irrigation system is problem free. Poor water coverage caused by lack of constant pressure, improper head spacings, poor choice of heads, wind and topography is common on golf courses. Often, something as simple as replacing nozzles with those that have a different delivery rate or trajectory can significantly improve uniformity and system efficiency. Leaks in irrigation systems, whether pressure leaks or line drainage leaks, waste water and cause turf growing problems. Golf course problems caused by standing water (annual bluegrass and marshy areas) can often be directly related to irrigation problems.

Use efficient irrigation equipment. The efficiency of an irrigation system depends a great deal on the operator. Modern golf course irrigation controllers can time applications to seconds, not minutes, and value-in-head sprinklers can efficiently handle small scale landscape features. Some recent developments in tying soil moisture measuring devices directly into irrigation controllers allows automatic control and efficient irrigation. Equipment that shuts down irrigation when it rains is available. Also, devices that measure evaporation and activate automatic controllers have been researched.

Sprinklers that water in straight lines, and those that have adjustable arcs are helpful in achieving efficient irrigation. Sprinklers that throw water high into the air and those that produce very fine droplets can be very inefficient if used on bright, windy days.

Cyclic watering. Sprinklers that deliver in excess of 1.0 inch of water an hour are used to water turf. On heavy and compacted soils, especially on slopes, runoff can be significant unless the sprinklers are run only for short periods.

Cycling the water back and forth on an area for short periods of time will allow water to get down into the soil to the desired depth without much loss.

Mow and fertilize for water savings. A turf cut tall will use more water than if it were cut short. However, tall cut turf has a better root system, and is more efficient in obtaining soil moisture. Therefore, tall cut turf will withstand moderate drought better than if it is cut low. Highly fertilized turf tends to have higher ET than that grown at low fertility. Although decreasing fertility decreases water use, a decrease in turf vigor could lead to other problems.

Consider shade. Turf grown in shade uses significantly less water than that in the sun. Similar irrigation practices on grass in the shade and sun can lead to increased disease problems, and invasion of shade and water tolerant (annual bluegrass and rough bluegrass) grasses. In arid and semi-arid regions, reducing watering in tree shaded areas can lead to serious tree problems. In most instances, trees are dependent on the water applied for turf use.

Aerify and dethatch. Thatch can be difficult to wet, and it can increase runoff. In addition, the thatch can directly absorb significant amounts of water, keeping it from percolating deep into the turf root zone. Aerifying, dethatching, and using wetting agents are possibilities for reducing water problems relating to thatch.

Aerify compacted soils. Compaction of heavy soils from foot and cart traffic is a major problem on golf courses. In many cases, more permanent approaches such as grass pavers, and soil amendments would be a better approach to solving compaction problems than aerification. Nevertheless, the aerifier holes that remain open as small reservoirs for catching and speeding water movement into the soil can help solve the problem of getting water into compacted soils.

Solve isolated dry spot problems Isolated dry spots are common on sand base golf greens. Aerification, spiking, and/or wetting agents are used to lessen the problem. Without treatment, isolated dry spots can cause severe damage, even if the greens are watered heavily.

Sometimes dry spots on fairways result from clay pockets, irrigation shadows from trees or shallow rock and buried debris. In order to provide adequate soil water storage capacity, buried obstacles may need to be dug out and replaced with soil, or irrigation changes may be needed.

Water when evaporation losses are low. The best time to water turf may well be in the early morning. Usually, at that time there is less wind, and direct evaporation is low. However, play on golf courses can start very early in the morning, and few systems are capable of providing needed irrigation in the couple of hours around sunrise. Therefore, night watering is a common practice. In dry areas, something like 25% of irrigation water from day time watering may be directly lost to evaporation. This alone is enough to encourage night watering in arid regions.

Take pests into account when watering. Root feeding insects significantly reduce turf roots; thus, water uptake can be greatly reduced. With a heavy infestation of grubs the grass can often be pulled up similar to a newly laid sod. Consequently, along with grub control there is need to water the grass frequently, just like a new sod, until it reestablishes a good root system. With diseases, watering can sometimes be a deterent to serious problems. With stripe smut, extended drought can kill diseased plants, while those without smut can recover rapidly from drought. It should be kept in mind, however, that turf that is wet for prolonged periods of time may be more susceptible to infestation of pathogens.

Of course there are several other considerations in turfgrass water management. Those interested in an in-depth discussion are encouraged to obtain a copy of "Turfgrass Water Conservation" Publication 21405 from Publications, Div. of Agric. and Nat. Res., Univ. of California, 6701 San Pablo Avenue, Oakland, CA 94608-1239.

NEMATODE DAMAGE AND CONTROL ON GOLF COURSES

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Nematode damage is severe on some golf courses in North Carolina. The problem occurs most frequently in the southeastern and southcentral part of the state where soils are very sandy. All types of grasses used on golf courses can be damaged, but nematode damage is usually more severe on shorter cut grasses and high use areas such as greens, tees and fairways. Symptoms of nematode damage usually appear as weak and thin turf with nutrient deficencies which wilts rapidly during dry weather. These symptoms may be caused by other problems such as poor fertility, lack of irrigation and some other diseases. Root stunting, excessive branching and even death of roots may occur with some nematodes. These symptoms are not usually adequate to identify nematodes as the major problem, and soil samples must be assayed for nematodes. A regular soil test is also recommended to eliminate nutritional problems as a major factor because some nematode problems can be overcome with proper fertilization and irrigation.

Nematodes are small eel-like worms that are too small to be seen without a microscope. Most of the ones that damage turfgrasses live in the soil and in roots. Nematodes that damage plants have small stylets which are small needle-like structures that are used to puncture plant cells to obtain nutrients or to inject substances into plant cells. Nematodes that are not parasitic on plants do not have stylets. Different nematode species that attack turfgrasses cause root stunting, death of roots, knots on roots and some cause no apparent damage even at high numbers. Nematodes usually do not kill the host plants, but weaken the plants and make them more susceptible to other stresses. Nematodes reproduce by eggs that hatch into small nematodes called larvae. The larvae develop through four molts in which the skin is shed to adults. The life cycle may be completed in three to four weeks with each adult female nematode producing several hundred eggs in a short time. Nematodes that feed on turfgrasses can be divided into endoparasites which move into the plant tissue and into ectoparasites which remain outside the tissue and insert only the stylet into the epidermal

cells. The ectoparasitic types such as the sting nematode cause the most damage on turfgrasses.

Nematodes that are found most frequently in soil from turfgrasses are ring, stunt, spiral, lance, stubby-root and sting. Only the sting and the stubby-root nematodes have been shown to cause severe damage on turfgrasses in research projects at North Carolina State University. The other nematodes are often found in high numbers, but greenhouse and field experiments have not demonstrated severe damage from the ring, stunt and lance nematodes. Recent results have shown that the ring nematode may alter nutrient ratios in plant tissue and may contribute to a slow decline of turfgrass plants. The sting nematode is known to be the most damaging nematode which occurs in the sandy soils of eastern and southcentral North Carolina. It is difficult to grow good quality turfgrasses where this nematode is present without using nematicides. Many of the golf greens and some tees and fairways in eastern North Carolina have been treated with nematicides to help overcome the effect of this nematode. The stubby-root nematode occurs on turfgrasses throughout the state and have been shown to cause severe damage to cool season turfgrasses in greenhouse experiments. This nematode reproduces very well in the course sandy type soil mixtures that are recommended for golf greens. Although this nematode may cause damage in the greenhouse, it has been difficult to demonstrate damage on golf greens because available nematicides do not control this nematode very well in an established turf. Therefore, the sting nematode appears to be the most important nematode on golf courses in North Carolina and fortunately this nematode is limited to the eastern and southcentral part of the state.

Only three chemicals, nematicides, are currently labelled for the control of nematodes on turfgrasses. These nematicides are Dasanit, Mocap and Nemacur. These chemicals are very toxic to humans, animals and birds and should be handled and applied very carefully according to label directions. Portions of the golf course that are being treated with nematicides should be closed to golfers until the area has been irrigated with at least 1/2 inch of water. These nematicides are formulated as granules for application to turfgrasses and should be applied evenly at the recommended rates. Drop type spreaders are recommended to prevent additional exposure to these toxic chemicals and to help obtain uniform application. The grass leaves should be dry when the chemicals are applied to prevent excessive burn to the turf. Mocap with cause severe burn if the leaves are wet when this nematicide is applied. The turf should be irrigated with about 1/2 inch of water immediately after treatment to wash the

nematicides into the soil and to remove them from the leaves to prevent burn and to insure safety to golfers. All of the nematicides can be used on bermudagarass, but Mocap should not be used on bentgrass because it will cause severe damage. Nemacur has given the best control of the sting nematode for a longer period of time and is currently the best material to use on golf greens.

Some management practices can be used to help overcome the damage from nematodes. First of all the soil should be assayed for nematodes to determine if high levels of damaging types of nematodes are present. The use of good fertilization programs to insure proper levels of nutrients and soil pH, irrigation to supply adequate soil moisture, and higher cutting heights will help turfgrass tolerate certain levels of damaging nematodes. In some cases an alernative turfgrass species may be considered. For example, bentgrass will be more susceptible to the sting nematode than bermudagrass, and bermudagrass can be used on greens in eastern North Carolina in place of bentgrass to avoid some nematode damage.

Information presented above indicates that certian nematodes can damage turfgrasses throughout North Carolina, but most of the damage is in the the eastern portion of the state. If a nematode problem is suspected, soil samples should be assayed for nematodes to determine if high levels of damaging types of nematodes are present. Your local agricultural extension agent can supply you with nematode assay boxes and information sheets. The samples can be assayed by the North Carolina Department of Agriculture for a small charge. A good turfgrass management program is important in preventing and helping to overcome nematode problems. The nematicides may be needed in many cases, but do not expect great results from them without good management practices.

OVERSEEDING BERMUDAGRASS TO CONVERT TO BENTGRASS

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The central focus of the slide presentation was to explain the existing conditions of the greens at Cape Fear Country Club and in that way help the listeners understand the management practices used and the results we have obtained from our overseeding program.

Cape Fear Country Club was started in 1896 and the private 18-hole golf course was built in the early 1900's by Donald Ross. For many years the pros visited Cape Fear to play in the Azalea Open Golf Tournament.

The golf course is one of the oldest in the country. We have hybrid bermudagrass on the greens and common bermuda on the tees and fairways.

The seven links in turfgrass management listed below were used as an outline in explaining the bentgrass overseeding program. These 'links' are a valuable aid in seeking answers to problems and/or developing an effective and practical program to economically maintain attractive and healthy turfgrass.

Link 1 - Variety Selection:

The greens are in their fourth year of being overseeded with Penncross Bentgrass at a rate of 1-1½ pounds per thousand square feet using a drop spreader and going two directions. The greens are overseeded in the spring and again in the fall. Timing is important, and in choosing a seeding date in the Wilmington area I refer to our daily weather records and pay close attention to soil temperatures.

Link 2 - Soil Preparation:

Light, frequent topdressing after seeding using the Hahn Spray Pro 44 with Vicon spreader improved seed germination and plant growth initiation. Topdressing has always been an important practice in putting green management. It is a factor in maintaining smoothness, uniformity, and relief from compaction. Topdressing improves internal characteristics in the soil profile, reduces thatch accumulation and improves the putting green quality and speed.

Sandy topdressings are used to improve the original soil profile, but the sandy material must have the correct physical characteristics to avoid the problems of soil layering.

Link 3 - Mowing:

The greens are mowed at 3/16", whenever possible we avoid mowing a clean up circle to reduce wear around the edge of the green.

Link 4 - Irrigation:

Using an automatic irrigation system the greens are lightly watered several times a day until satisfactory germination and seedling emergence is obtained. Some hand watering is necessary on localized dry spots.

Link 5 - Aeration and Thatch Control:

The primary concern in putting green soils is that they withstand intense traffic and drain well to provide a playable surface in wet or dry conditions.

Soil layering, from years of topdressing with different soil types and soil compaction, from years of heavy traffic, are two major problems at Cape Fear Country Club.

These soil layers have created a barrier which turf roots cannot penetrate and water movement between the layers is restricted.

The greens are aerified using a Ryan Greensaire with ½" tines. The plugs are removed from the surface and sand is incorporated into the open aerification holes in an effort to improve soil air and water movement in the soil profile and to stimulate root growth and development.

I have taken several soil profiles from each green and in each case the root systems were shallow and underdeveloped. Turf roots will not grow well under compacted soil conditions and bentgrass is particularly sensitive to soil compaction. In each of the soil profiles taken no living roots were found below a depth of two inches, and most were less than one inch deep. A strong healthy root system is vital in obtaining good turf. Improving soil conditions through deep aerification or drilling of the greens, and the proper use of sand will help in providing better soil growing conditions.

Link 6 - Fertilization:

The greens are managed and maintained to promote bentgrass growth through the timing of our management practices. The fertilization program is geared toward increasing root growth and development. A major part of the program is the timing of fertilizer applications, the application methods, and the types of fertilizer used.

The use of high potassium fertilizers during periods of optimum root growth will strengthen our very weak root system. For cool season turf, such as bentgrass, the optimum soil temperature for root growth is 60°F with a minimum soil temperature of 33°F. The early spring and late fall fertilizer applications include increased amounts of potassium to stimulate root growth.

Soil tests are taken annually to determine fertilizer and liming needs. In general 6 to 8 pounds of nitrogen are applied to the greens each year in frequent, but small amounts to produce a higher quality turf and to avoid flushes of growth.

Link 7 - Pest Control:

Diseases:

Diseases have not been a major concern at Cape Fear Country Club. A preventative fungicide program has reduced the incidence of disease.

Algae is a reoccuring problem on several greens due to the poor drainage. Hydrated lime has proved to be both effective and economical in the treatment of algae.

Insects:

Attacks by armyworms, cutworms, sod webworm, and white grubs have called for an insecticide program to help reduce these populations.

Infestations of sting nematodes is a serious problem at Cape Fear requiring the use of Soil Brome 90 in the past and the present use of Nemacure to lower nematode populations and reduce damage to turf.

Weeds:

Reoccuring infestations of goosegrass, crabgrass, and poa annua in the greens is a result of the poor soil growing conditions. Anytime there is a weak spot or thin area of turf weeds will invade the space. The fact is, that the best weed control is a thick healthy stand of turf!

This past spring was the first time we used the Scotts Bensulide/Oxadiazon for the pre-emergent control of goosegrass and crabgrass in our greens. This chemical is not recommended for use on seedling bentgrass. A full rate is applied in the spring followed by a half rate application in early summer, approximately 90 days apart. We recieved good results with this chemical and plan to use it again this year.

Not every chemical will work well on every golf course. This is partly due to the differing soil types and the activity of the chemicals in the soil.

Chemicals have not been applied to the greens to set back the bermudagrass in any way. The percentage of bentgrass in our greens ranges from 20 to 80 percent. There are four or five greens that have enough bentgrass in them to provide a putting surface, and this year Tupersan will be used on these greens to set back bermudagrass growth.

Overseeding the greens at Cape Fear Country Club to convert to bentgrass has shown some success, but our progress is limited by the poor soil and drainage conditions.

The members at Cape Fear have been considering complete renovation of the golf course. Renovation of the greens to meet USGA specifications will be the best way to correct the soil problems. One of the characteristics of greens that have a poor soil mix, inadequate drainage, and a weak root system is that they will look alright under ideal conditions, but when put under any kind of stress they will decline rapidly. If the soil and drainage problems are not corrected through renovation, my management program will continue to focus on improving soil conditions through deep aerification and the use of sand to improve soil air and water relations, and to promote root growth.

OVERSEEDING BERMUDAGRASS GREENS TO CONVERT TO BENTGRASS

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A conversion to a bentgrass putting surface may seem to be the answer to a thin inconsistant putting surface of bermudagrass, however, many factors should first be considered before attempting such a change. Many courses have had good success switching from bermudagrass to bentgrass. Their rate of success, however, should be carefully analyzed, noting the factors they had to overcome, the time requirements and the required changes in management practices.

In my initial opinion, Pine Valley Country Club was an unlikely candidate for a bentgrass conversion. Only at the request of my Green Committee Chairman did I seriously study this alternative. Without adequate time to assess the entire situation, I made the decision to attempt an "overseeding conversion" to Penncross bentgrass. By using an overseeding method, I knew if all did not go well, there would be ample time to change my management practices back to promote the Tifton 328 and regain an adequate putting surface before summer. Although we did not acheive 100% cover of bentgrass from September of 1982 through mid April of 1983, it was rather easy to see we had a good beginning and that it would probably be a good idea to continue with the conversion program through the summer. This decision was easily made after seeing how both grasses complemented each other.

I was sure by late April that we would not have a green with just one grass. However, I was also certain that we would have 100% cover with a mixture of the two grasses. The bent was doing well, especially in the areas that had been problem areas for the bermudagrass.

The fertilization program was changed to promote the bentgrass, leaving the bermuda under nourished throughout the summer. By the end of the first year the greens were 50 to 60 percent bentgrass, the overall putting quality had improved, the amount of play had increased and we were committed to a program that hopefully would oneday produce 100% Penncross bentgrass greens at Pine Valley Country Club.

In estalishing bentgrass many important factors should be considered. It was necessary at Pine Valley to correct drainage problems and to remove trees around some greens to promote adequate air movement. Being in the Coastal area it was apparent that disease problems would be a prime concern, second only to possible heat and moisture stress.

During the first year of establishment (9/82 to 9/83) greens were aerified from 4 to 6 weeks in advance of the seeding to insure enough time for the aerification holes to mend. I felt it was necessary to remove as much thatch and leaf material as possible to insure good seed-soil contact. This was done through verticutting in several directions over a two week period prior to seeding. The greens were topdressed the day before seeding using a 70% sand and 30% peat topdress mixture. The greens were initially seeded with 2.5 pounds of Penncross bentgrass and 6 pounds of Pennlawn red fescue per thousand square feet. Seed was added for the next 3 to 4 weeks to touch up areas with insufficient germination. The greens were closed to play for the next 21 days. This was possibly the most important step during the first year of establishment.

Fertilization followed the first mowing, which began 10 to 14 days after seeding. The initial fertilization consisted of small amounts of soluable nitrogen and moderate rates of phosphorus and potassium. Greens were topdressed lightly twice a month for the next two and a half months. The height of cut began at 5/16" and was gradually lowered to 7/32" and remained there throughout the Spring.

Greens were reseeded in late April at a rate of 1.5 pounds per thousand square feet. Four weeks later the greens were aerified, the plugs were verticut and dragged, partially filling the aerifier holes. The greens were treated on a preventative basis for control of Pythium beginning in May and continuing through September. Other broadspectrum fungicides were applied as needed.

During the first year, 8 pounds of nitrogen, 2 pounds of phosphorus and 3.5 pounds of potassium were applied per thousand square feet.

Considering the results of the first year it was evident the conversion could work.

At the beginning of the second year of the the conversion program (9/83 to 9/84) the greens were again seeded, using 2 pounds per thousand square feet of Penncross bentgrasss. The seeding was done in early October. The greens were verticut in three directios prior to seeding, but were not aerified until late October - approximently four weeks after seeding.

Fertilization the second year consisted of 5.5 pounds of nitrogen, 2.5 pounds of phospherous and 3.5 pounds potassium per thousand square feet. All fertilize was applied between mid October and early June.

Some greens were seeded in the Spring for the purpose of touching up thin areas. Usually these thin areas were the same areas where the bermuda had been the strongest during the Fall. Fungicides were applied as necessary with the exception of those fungicides used for the control of pythium that were applied every three to five weeks.

Herbicides were used for the first time for the control of crabgrass and goosegrass. Both pre-and post-emergence

chemicals were used with good to excellent results and with no damage to the bentgrass. At the end of the second year the stand of bentgrass was estimated at 70 to 90 percent.

Beginning the third year of the conversion (9/84 to 9/85), some greens were lightly seeded using from .5 to 1.5 pounds of Penncross per thousand square feet. The greens were aerified and topdressed several weeks after seeding. Fertilization was delayed until November so as to not promote bermuda growth during the warm days of early Fall.

The fertilization program during the third year consisted of 4.5 pounds of nitrogen, 1.6 pounds of phosphorus and 6.5 pounds of potassium per thousand square feet. I beleive the increase in potassium provided a stronger turf during the summer months and reduced the excessive loss of moisture through transpiration during extreme high temperatures. By reducing the wilt tendencies the bentgrass provided more competition to the bermudagrass during the warmer months.

For the first time since the beginning of the conversion program, chemicals were applied to retard the growth of the bermudagrass. Tupersan was applied in early September at half rates for the sole purpose of suppressing the vigor of the bermudagrass which seemed to be more prevalent in the high traffic areas. Suppressing the bermuda in the early fall allowed us to aerify and fertilize with the intention of promoting the growth of the bentgrass and not promoting competition from the bermudagrass. At the end of the third year the stand of bentgrass was estimated from 80 to 95 percent, with a few greens closer to 100 percent.

During the beginning of the fourth year only four greens were seeded. The germination was apparently unaffected by the Tupersan application made three weeks prior to seeding. More chemicals will be used next spring to help control the bermudagrass. High potassium fertilization will continue with at least one pound of potassium being applied for every pound of nitrogen.

In the years to come greens will be seeded as necessary and fungicide programs will be monitored closely to insure a disease free state.

Providing a good uniform putting surface is very important regardless of the grasses used. If one grass is not providing the desired surface it is necessary to first understand why. Only after gathering all information can anyone properly decide if a conversion program could benefit their situation. Only after this careful study and with proper planning and preparation should any conversion program be attempted.

OVERSEEDING BERMUDA TO CONVERT TO BENTGRASS

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Several factors influenced our decision to convert to bentgrass on the greens at Highland County Club. The following four factors helped us make that decision.

I. Greens Construction. Although our greens are push up, built in the mid 1940's, the soil nature to this area of North Carolina is very sandy so the internal drainage of the greens is very good. In addition, because of the degree of slope that Donald Ross incorporated into the greens, the greens have excellent surface drainage.

II. Improved Varieties of Perennial Ryegrasses. Because of the research and study dedicated to finding and developing the perfect overseeded mixture, the ryes in a sense have become too good. The perennials on the market now are very heat tolerant, disease resistant, and drought hardy. This fact relates directly to the third reason.

III. Transition. Ten years ago transition occurred in April or May as temperatures became warmer and the old common ryegrasses died. Now, as in the case present at Highland, transition occurs in late June to mid-July, leaving a limited growing season for the Bermuda. This fact is a great inconvenience for the golfing membership because transition now occurs at the height of the playing season.

IV. Winter Damage. Most of the greens at Highland have shade in the winter. This resulted in a very late transition. Sodding and plugging were done yearly at Highland simply because the Bermuda did not have a long enough growing season to cover. This resulted in a very rough putting surface during the height of the club's playing season. Our greens were always in the best shape the week prior to planting the winter overseed. Eliminating trees was not a possibility for obtaining sunlight. Due to the compactness of the layout, we felt we would lose too much of the native landscape and privacy associated with the club.

Planning Overseed Operation to Convert

I think the following five factors are very important to have a successful overseed of bentgrass into existing bermuda.

I. Communication. Communication to your membership is very important. The successful conversion from Bermudagrass to bentgrass is likely not to happen in one growing season. I estimate a three year operation of overseeding with bentgrass before the conversion will be 100%.

II. Management of the Bermuda Prior to Overseeding. The management of the Bermuda the season prior to starting the conversion program is critical. Once the putting surface had covered with Bermuda, I turned my management practices from Bermudagrass to bentgrass. From late June through October no nitrogen was applied to the greens. I maintained color with weekly applications of chelated iron at the rate of two ounces per thousand square feet. This allowed me to choose an earlier seeding date and not have the concern of the Bermuda being too aggressive.

III. Seeding Date. The seeding date I chose was August 26. This date is approximately four weeks earlier than the seeding date I used when rye was planted. I feel that an eight week period of growing weather is a must to obtain enough lateral movement of the bentgrass to receive a sound winter playing surface.

IV. Overseeding Procedure. Ryes or fescues were not used with the bentgrass when I seeded. I felt that if rye or fescue was used, a competition problem with the bentgrass would arise during the spring growing season. The seeding procedures used were:

A. Vertical Mowing: Greens were verticut in two directions at 1/6 of an inch the day of planting.
B. Seeding. Drop spreaders were used for seeding and were calibrated at one pound per thousand square feet. I seeded in two directions giving a two-pound per thousand square feet.
C. Topdressing. Greens were lightly topdressed with just enough soil to insure seed soil contact at germination.
D. Drag. A piece of carpeting was used for a drag mat. I preferred this over a brush or chain mat to reduce the amount of material moved.

V. Water Management. From the day of seeding until germination was complete, water was applied very lightly at two hour intervals. Due to the time of year and the seed size, I felt this was necessary to insure that the seed coats stayed damp. Germination began in four days and was 90% complete in seven days. From that point, hand syringing was done during the day, and all other irrigation was performed at night.

Management of Overseed

I. Disease Control. Because of the time of seeding, a strict preventative disease control program was followed. Subdue was sprayed every seven to ten days. Various other broad spectrum fungicides were also applied every ten to fourteen days.

II. Cutting Height. The mowers were raised to 9/32 of an inch until night temperatures were consistently below 60 degrees F. They were then dropped to 1/4 of an inch and maintained at that level through the winter.

III. Aeration. When night temperatures dropped to 50-55 degrees F, the greens were aerated with 3/8 of an inch tines. This promoted a greater root depth, supplied oxygen to the soil, and cooled the soil temperatures to halt any Bermuda growth.

A second seeding of bentgrass was broadcast at a rate of one pound per thousand square feet immediately after the aeration. This second seeding insured that there would be no large areas that were free of bentgrass after a killing frost. The beauty of this seeding was that the mowing height was never changed. Most of the seed germinated in the holes.

IV. Fertilization. Nitrogen was not applied to these greens in the fall until soil temperatures were consistently below 60 degrees F. At that time, one and one-half pounds of soluble nitrogen were applied in three applications. As a final feeding of nitrogen for the fall and winter, a one and one-half pound of water soluble nitrogen was made. During this same time frame, three one pound applications of sulfate potash were made.

Spring and Summer Management

Another two pounds of nitrogen per thousand square feet was applied from March through April after which time only chelated iron was added for color. All irrigation was done at night and all other watering was done by hand syringing. I did not discourage the Bermuda growth the first year; however, I did not manage for it either. All management practices were for the development of bentgrass. After completion of the second full season of this program, I will begin to chemically remove the Bermuda to complete the conversion.

WEED CONTROL IN BERMUDAGRASS FAIRWAYS

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In planning a weed control program one must select the most effective and economical plan for his situation. Preemergence herbicides may be used to control summer annual grasses, winter annual grasses and/or certain broadleaf weeds. Postemergence herbicides are used to control summer annual grasses, winter annual grasses, perennial grasses, nutsedge and annual sedges or broadleaf weeds. The appropriate herbicide must be matched with the weeds to be controlled.

Winter annual grasses are primarily annual bluegrass and ryegrass. Common winter annual broadleaf weeds are chickweed, corn speedwell, henbit, and spurweed. Preemergence control particularly of annual bluegrass (Poa annua) can be obtained with the herbicides which are commonly used for preemergence crabgrass control, for example: Balan, Betasan, Dacthal, Devrinol, Pendimethalin, Ronstar and Surflan. Less expensive herbicides for winter annual grass and broadleaf control are atrazine and simazine. These two herbicides are absorbed primarily by the roots of the weeds as they germinate. Atrazine does have some foliar penetration. They will control annual bluegrass even if it is emerged at the time of treatment. Applications of either herbicide at 1 lb active in November to early December has given effective control of annual bluegrass and winter annual broadleaf weeds. When applied in January and February at these rates, control is unacceptable. We have also observed delayed green-up of bermudagrass when either herbicide is applied in early February. Kerb 50W can be applied for pre- and postemergence control of annual bluegrass in bermudagrasses. It acts mainly through root absorption and also controls chickweed, henbit and corn speedwell. Sencor 75 Turf Herbicide is labeled for postemergence control of annual bluegrass in bermudagrass. This compound is absorbed by the roots of the weeds. It also controls chickweed, corn speedwell, henbit, hop clover and parsley piert. Still another herbicide for postemergence control of annual bluegrass and winter annual broadleaf weeds in dormant bermudagrass is Roundup. It is applied at the rate of 12 to 16 fluid ounces per acre and 0.5% by total spray volume of a non-ionic surfactant. Apply in 5 to 20 gallons of water per acre. All of the above herbicides may be used only on bermudagrass which has not been overseeded.

If broadleaf weeds are the only problem, a turf product containing two or three broadleaf herbicides may be selected. Examples of these products are: Trimec, Trexsan, Weedone DPC, Turflon D and Three-Way Selective Herbicide.

Summer annual grasses such as large and smooth crabgrass and goosegrass may be controlled with preemergence herbicides. Pos-

sible preemergence herbicides are: Balan, Betasan, Devrinol, Pendimethalin, Ronstar, Surflan, and XL. Ronstar has generally been more favorable than the other herbicides for preemergence goosegrass control. Pendimethalin and Surflan also show promise for improved goosegrass control. Split applications of preemergence materials may contribute to more favorable goosegrass control. For North Carolina conditions, the first application should be applied when the dogwoods begin to bloom and the second six weeks later.

MSMA is commonly used for postemergence control of crabgrasses, goosegrass, dallisgrass, nutsedge and annual sedge, and sandbur. We have obtained effective control of crabgrass, goosegrass and dallisgrass with two applications of MSMA spaced 10 days apart at the rate of 1.5 lbs active per acre. Many superintendents feel the addition of 1/8th lb active of Sencor 75 Turf Herbicide to the MSMA improves control. Some general suggestions for applying postemergence herbicides for grass weed control are: 1) Effective control of annual grass weeds at the three to four leaf stage can be obtained with one application. 2) Larger plants require two applications 7 to 10 days apart. 3) Apply when it is at least 80 degrees F and there is good soil moisture. 4) Apply uniformly in 30 to 40 gallons of water per acre. 5) Do not water or mow for at least 24 hours. 6) Do not treat new seedlings until the third mowing. 7) Do not apply to turf growing under stress conditions.

Summer annual broadleaf weeds may be sprayed in the spring or early summer with products containing two or three broadleaf herbicides which are mentioned in a previous paragraph. Some conditions for applying postemergence broadleaf herbicides in bermudagrass turf are: 1) Apply to actively growing weeds. 2) The temperature should be 60 to 80 degrees F. 3) There should be adequate soil moisture. 4) Apply before mowing to allow ample leaf surface for herbicide absorption. 5) Spray applications are generally more effective than granular applications. 6) Avoid spray drift to susceptible plants. 7) Check the herbicide label for sensitivity of perennial turf grasses. 7) For difficult to control weeds use a minimum label rate and repeat in 10 to 20 days.

Effective weed control in bermudagrass golf course fairways depends upon selecting an appropriate chemical for the weeds to be controlled, taking into consideration the cost and safe use of the herbicide.

BERMUDAGRASS PROBLEMS ON GREENS IN 1985

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A tour of several eastern North Carolina golf courses during August of 1985 found that over 60% of bermudagrass greens visited were observed to be in only poor to fair condition. Poor cover this late into the summer increases the difficulty in providing a uniform base for fall overseeding and often reduces the rhizome development that is necessary for avoidance of cold temperature stress. Several factors may have contributed to the winter or spring loss of bermudagrass during the past year. These factors include winter injury (low temperature stress), desiccation, late spring frost, low potassium levels, overseeding competition, irrigation regime, transition management, and shade.

Bermudagrass loss due to low temperature stress during the 1985 winter was not as great as in many previous years. This wasdespite the record cold weather (-8 °F) in January. These record low temperatures were not as injurious as they might have been because soil temperatures were still relatively high from a very warm fall and December (Table 1). However, since bermudagrass can suffer significant losses at soil temperatures of only 22 to 26 °F, many weak stands were injured by this brief but very cold weather. On the whole, air temperatures during January and February of 1985 were below normal, while March and April air temperatures exceeded normal values (Table 1).

Desiccation losses occur when the bermudagrass root system cannot provide the water requirements of the shoot during periods when soil temperatures are still cool, but the air temperatures are relatively warm. A warm breeze increases the demand for water from the shoot, while the cool soil reduces the root's capability to transport water. These two situations combine to result in a wilting of the turf crown and shoot, despite the presence of water within the soil profile. Desiccation is typical during late-winter and early-spring when soils are still cool, yet air temperatures during March and April can approach the high 80's and low 90's almost anywhere in North Carolina. Early-spring (March and April) are also the most windy months, which further increases the draw of water from the plant. During 1985, precipitation in most of the state was significantly below normal during January, March and April (Table 1). Given the typical soil and air temperature differential and wind patterns during late-winter and early-spring, the potential exists for significant losses of bermudagrass from desiccation. Such losses are largely unrecognized and easily misinterpreted as low temperature kill because the turf fails the greenup in the spring following both stresses.

Table 1. Temperature and precipitation at Raleigh, NC during the 1984-85 winter and early-spring.

Month	Mean Air Temperature		Soil[2]	Mean Precipitation	
	Normal[1]	Actual		Normal	Actual
	- - - - - °F - - - - -			- - - inches - - -	
Dec	42.0	49.2	42.5	3.14	3.12
Jan	39.6	37.0	34.7	3.55	2.81
Feb	41.5	37.0	36.8	3.43	5.24
Mar	49.4	52.6	47.0	3.69	2.23
Apr	59.4	61.0	56.6	2.91	0.64
Mean	26.4	47.4	--	Total 16.72	14.04

[1] Source: NOAA, Asheville, NC, Normal based on period 1951-1980.
[2] Mean temperature at a 4 inch depth at the NCSU Turf Field Center.

Spring frost (temperatures at or below 32 °F) have occurred in North Carolina through May in Asheville and Raleigh, and through April in Wilmington. Frost after spring greenup of bermudagrass will usually burn-back the new shoot tissue. Fortunately, healthy stands of bermudagrass seem to be capable of withstanding several such late frosts in the spring.

Low potassium levels can also result in bermudagrass loss because of the many roles this nutrient plays in ensuring the health of the turf. This element is very important for maximization of cold hardiness, disease resistance, and water stress tolerance of the turf. Adequate potassium levels are necessary for the development of deep and extensive root systems.

Bermudagrass is not inherently very tolerant of shade conditions. In the shade this turf is also subject to greater winterkill from reduced exposure to the warming rays of the sun during the winter. Turf in the shade can stay colder longer compare to open areas. Additionally, moderate levels of shade during the summer may be heavy shade during the winter because of the lower angle of the sun in the sky at this time of the year.

Some bermudagrass loss can occur from winter overseeding operations. Preparations for overseeding (coring, slicing, mowing, dragging, etc.) do stress bermudagrass at a time when it is entering dormancy. Also, actively growing cool season overseeded turf is competitive with bermudagrass during the spring. Overwatering during the spring and early-summer tends to promote the growth of overseeded grasses. However, soil moisture is necessary for the proper spring greenup and growth of bermudagrass.

During the past 10 to 15 years, superintendents have observed an increase in the diversity and performance of cool season turfgrasses for overseeding bermudagrass golf greens. Today, overseeding mixes can include perennial ryegrasses, annual ryegrass, intermediate ryegrass, fine fescues, rough bluegrasses, Kentucky bluegrass and bentgrass. In addition to the development of many new overseeding cultivars, continual improvements in the heat tolerance and disease resistance of perennial ryegrass cultivars have increased their competitiveness with the underlying bermudagrass turf. Unfortunately, such competition can substantially slow the spring growth of bermudagrass and is often unnoticed until there is a sudden loss of the overseeded grass following heat stress or certain herbicide applications.

Studies in cooperation with Drs. W. B. Gilbert and A. H. Bruneau at Raleigh and Hampstead, NC over the past four years have been conducted to assess the relative persistence and competitiveness of cool season turfgrasses into a Tifgreen bermudagrass turf under golf greens conditions. Over 60 different overseedings were evaluated in these tests. The persistence through July of fall established overseedings ranged from only 10 to almost 80%. This demonstrates the wide range in the summer persistence of available overseeding grasses.

Overseedings established in October 1982 that persisted the greatest through August of 1983 included Birdie, Delray, Elka, Gator, Fiesta, Loretta, and Prelude perennial ryegrasses. Stands of these grasses ranged from 17 to 28% cover, while Barclay, Goalie, Manhattan, and Pennfine perennial ryegrasses all had less than 5% cover at this date. The intermediate ryegrasses 3CN and Oregreen, rough bluegrass, and annual ryegrass also had less than 5% cover in August.

Overseeded perennial ryegrass persistence through July 1985 following consecutive annual overseeding in October 1982 and 1983 (plots were not overseeded in fall 1984) was greatest for Birdie, Delray, Fiesta, Gator, and Prelude, each averaging over 40% cover. Intermediate ryegrasses, annual ryegrass, rough bluegrass and Barclay, Diplomat, Goalie, Manhattan and Pennfine perennial ryegrass had the least persistence through July 1985, with about 20% cover or less. Plots overseeded with these least persistent grasses also had the greatest bermudagrass cover (average cover across these plots was 85% bermudagrass) in July 1985. The most persistent overseeding grasses tended to have the lowest bermudagrass cover in July 1985 with a mean value of only 38%.

The national overseeding trial which begin in fall 1984 included many of the grasses evaluated in the aforementioned studies and provided consistent results. At the Raleigh location, the best bermudagrass (60 to 90%) cover in July 1985 followed fall overseeding with Bianca, Loretta, Master, and Yorktown II perennial ryegrass. The poorest bermudagrass stands (less than 40%) followed fall overseeding with Birdie II, Cowboy, Gator, Omega II, Ovation, and Tara perennial ryegrasses. At the Hampstead location, the best bermudagrass cover in June was 57% for plots seeded to Agree intermediate ryegrass. At Hampstead, plots fall (1984) overseeded with Allstar, Brenda, Citation II, Loretta, Ovation, and Palmer perennial ryegrass had less

than 25% bermudagrass in June 1984.

It is clear that turf managers cannot assume that all overseeding grasses will persist equally through the spring and summer. In fact, these data demonstrate that within the perennial ryegrasses there is a wide range in summer persistence characteristics. Understanding which grasses are most persistent will provide the superintendent with an ability to correctly select an overseeding grass (es) to meet his specific situation. Those with late-spring tournaments might prefer more persistence overseedings to ensure a uniform high quality putting surface. Conversely, those with early-summer events might select less persistent type to ensure a quicker transition back to bermudagrass. Additionally, those with weak bermudagrass stand might select overseeding that are less persistent to minimize the competition with the bermudagrass. In any case, it is apparent that turf managers will have to adjust their spring management regimes to account for the level of summer persistence of a given overseeding selection.

PREPARING FOR AND HANDLING OF A PESTICIDE SPILL

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Accidents do happen! Pesticide spills you may have to deal with will range in degree of severity. Hopefully you will be prepared to handle them. Here are some ideas, suggestions, and guidelines for your use based on several years of experience.

Four basic steps should be followed when handling any type or size of spill.

I. First Aid

First and foremost is that emergency medical assistance be given to any person involved and hurt. It is more important to save a life rendering assistance to the injured than trying to stop any flow of pesticide.

II. Attempt to Contain the Spill

Be resourceful at this by utilizing whatever is available. For example, in one incident we commandeered a nearby backhoe and its operator from a road crew. The backhoe enabled us to dike the spill quickly and prevent it from flowing into a drainage ditch.

Shovels, rakes, axes, and other hand tools can be used to dig up turf, soil, etc. and divert the spill into a containment area.

III. Notify your Employer

Your employer and/or main office can help render further assistance in making the necessary phone calls to the proper authorities, insurance people, and in dispatching extra personnel or vehicles.

IV. Clean Up

Minor spills (5-10 gallons) from hose breaks, etc., can be quickly and efficiently handled by kitty litter (absorbent clay) or hazorb pillow blocks (available through Textile Chemical Co., P. O. Box 1096, Reading, PA 19603).

Major spills need to be diked and contained so they can be cleaned up properly. Once the spill is contained, our experiences with a small gasoline sump pump have been encouraging. By using a portable gas sump pump, you are able to transfer the contained spill into a truck tank, or other suitable holding container. The spilled material may now be re-used for its original purpose. You will then be left with virtually no pesticide to dispose of except what soil or material you used to dike the spill. In most instances, this amount of "contaminated" soil is small and can be disposed of safely and quickly in a nearby approved land fill.

By planning ahead you will be better able to handle this or any type of emergency situation and avoid making "panic" decisions. One item you might consider is developing a simple notebook that is your business "plan of action" manual. Items in the manual that will be helpful include:

1. **Contact priority sequence** of people that need to be informed (home and office phone numbers), such as:

   - Manager or Supervisor
   - Business office telephone number
   - National Coast Guard Response Center 1-800-424-8802
   - Chemtrec 1-800-424-9300
   - EPA Pesticide Emergencies (313) 353-2318
   - Railroad Emergency Center Explosives (202) 293-4048
   - Poison Control Center (local telephone number)
   - State Department of Agriculture of Department of Environmental Resources
   - Any other name or agency your state or local jurisdiction may require.

2. **Record keeping reports** that your staff fills out for your files and for sending to the authorities. Items to record include:

   - Date/time/suspected cause of spill
   - Location and path of spill
   - Total amounts of pesticide dilution spilled exact quantities of each pesticide component
   - Any other pertinent information (i.e. people on the scene, whom you spoke to, etc).

Keep your employees up to date on materials being used. Insure that your vehicles carry a registration sheet with them that lists the common names of the materials in the

spray rig, what the dilution percentage is, and the chemical's EPA registration number. Good and accurate records are essential.

Plan now to stock necessary clean up items:

- Hard hat w/face shields
- Rubber gloves
- Rubber boots
- Coveralls(tyvec throw-a-ways or neoprene aprons)
- Cat litter (absorbent clay) or hazorb pillow blocks or activated charcoal
- Small gas powered portable sump pump

Always report spills to proper authorities. Accidents and problems won't go away by turning your head but they could become serious for you.

Good luck and be safe. the eyes of the public are watching all of our related industries. It is important that we protect them, the environment, and ourselves.

CHEMOPHOBIA--AN EXTENSION AGENT'S PERSPECTIVE

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Mother's Milk Unfit for Human Consumption; Pesticide Poisonings, Harvest of Illness; Cancer in a Spray Gun; Pastures of Poison -- Suburbia Under the Spray Gun. All of these are news articles concerning pesticide use -- Examples of "news media toxicology". Alan Caruba, a well-known public relations expert writes in a recent Pest Control Technology: "Most reporters come from a humanities background, graduating from college with a passing knowledge of Shakespeare and shaky grades in required courses such as Zoology or Astronomy. A significant lack of any scientific background is contributing to the media's role in scaring the public half to death with a constant barrage of sensational headlines" and divulge the facts. Although there are many responsible representatives of the news media who try to discover the truth, many writers are using sensationalism to sell their papers or magazines. Others appear to be attempting to negatively affect public opinion as far as pesticides are concerned. "Suburbia Under The Spray Gun" by Hal Rubin is one such example. Let me read you an excerpt from this article.

"Only three years before, Mediterranean fruit flies were spotted in the San Francisco Bay area. The attending panic resulted in repeated aerial sprayings, over a 1,300-square-mile portion of the state with the pesticide malathion, derived from organophosphates developed by Hitler's chemists as nerve gases in World War II. Those sprayings amounted to only a small percentage of the 300 million pounds of pesticides dumped on California soil each year, including highly toxic organophosphates, organochlorides and carbamates. But the Med fly experience was significant because it reaffirmed that despite the known hazards of pesticides, wherever insects go, pesticide applicators are right behind. Even heavily populated cities are not off limits." Very seldom will you find an out and out lie in an article of this nature but their viewpoint in my opinion is definitely skewered somewhat off-center.

Dr. Alice Ottoboni states in her book, The Dose Makes The Poison, that "the average person does not have the tools with which to make judgements about which reports should be taken seriously and which are of little concern. Thus, reasonable people are left with little choice but to act unreasonably to news media toxicology."

In addition, the public may be using a collection of flawed concepts with which to judge pesticides. Terry L. Witt, public relations manager with Dow Chemical suggests the following list: 1) Nature is good, and synthetic is bad. 2) If a substance is toxic, it is a hazard. 3) Risks are unnecessary and can be eliminated. 4) "Zero" is the only safe level for a chemical detected in our food, water, or environment. Any action based upon these fallacies is destined to create problems.

Let's partially rebut these concepts.

1) Mother Nature is far more ingenious and prolific in devising toxic chemicals than man. Many scientific estimates have come to the conclusion that our world contains many more natural toxicants than synthetic. An example of a natural toxicant is botulin, a toxin produced by natural organisms. One milligram of solution is capable of killing

20 million mice. Talk about building a better mousetrap! Biochemist Bruce Ames states in a 1983 newsarticle that "human consumption of nature's pesticides is probably at least 10,000 times higher than dietary intake of man-made pesticides....Nature is not benign."

2) The thousands of toxic substances in food do not automatically indicate it is hazardous as evidenced by the fact of our daily lives. This truism can also be applied to synthetic chemicals.

3) Risks are a fact of life and its impossible to eliminate risks. Why should we selectively eliminate risks without looking at potential benefits.

4) In many cases zero is an unattainable level. Regulations of chemical contamination these days are expressed in terms of parts per billion, levels that were undetectable a few years ago. 1 ppb is equal to one penny to 10 million dollars, one inch in 16,000 miles and one postage stamp in an area the size of Dallas, Texas. The public doesn't know that such contamination represents, in most cases, little or no actual danger.

Perhaps Dr. Ottoboni puts it best by saying: "we know there is a great lack of understanding in the public mind about what makes chemicals toxic, and about the word that has become a synonym for toxic...poison. The headlines tell us about the 'poisons' in our food, the 'poisons' in our water, the 'poisons' in our air--poisons everywhere! The indiscriminate use of the word "poison" has brought us into an era of poison paranoia.

There are two potential dangers in news media toxicology and its offspring, poison paranoia. One is the 'cry wolf' syndrome. When an alarm is sounded frequently without regard to the degree of emergency, the alarm becomes meaningless. A public blase' about harmful effects of chemicals is a public disinterested in making any changes in use practices relating to chemicals." For example, many of us totally disregard new announcements concerning carcinogens simply because of the number of commonly used substances which have been proclaimed to be carcinogens which we still use -- saccharin for example.

"The second danger is that a certain fraction of our population will become victims of a helpless, hopeless terror that chemicals from which they cannot escape - chemicals in their food, their water, their air - are destroying their health, shortening their lives, or dooming them to cancer."

Chemophobia is the word that has been coined to describe this almost irrational fear of chemicals. Such a fear is a form of stress that can be just as damaging as the chemicals that are feared and in some cases even more so. People who are suffering from chemophobia seldom believe any information that does not support their conviction that they are suffering from some sort of chemical poisoning. These people are frightened to death of chemicals.

Although Forsyth County can hardly be considered a hotbed of

chemophobia sufferers, the frequency of calls questioning the safety of various pesticides which are in common use both in the lawn and the landscape does appear to be increasing. The vast majority of these people are seriously concerned about the many chemicals reported to be harming them and the environment, but they don't necessarily fear them. Our obligation as educators and yours as potential users of pesticides is to make the public aware of the facts about the toxicity of pesticides in order to help them cope with news media toxicology, preserve their sanity in the face of chemophobia, and make informed judgements about the pesticides in their environment.

So what are chemicals? All substances are composed of chemicals and physical combinations of atoms and molecules. Thus everything in our world is chemical - food, water, clothes. Everything is "chemical". However what people are really concerned about are not chemicals, but man-made chemicals. In particular they dread pesticides. As you know, pesticides are substances, natural or synthetic, that are used to kill some pest - a creature or plant that has been determined to be undesirable.

There are countless chemicals that are as "toxic" as many of the pesticides, or more so, but the focus of fear seems to center on pesticides, One reason for this is the tremendous amount of publicity we mentioned earlier given to alleged or actual reports of damage caused by the presence of pesticides in the environment and even in our own bodies.

All of us are familiar with DDT; the Bhopal, India disaster, the Tordon cancer scare, and countless other newsworthy events which have been sensationalized by the various media. However, when you look at the number of actual deaths caused by pesticides and see that many, many more people die in auto accidents, you may wonder why all the attention and fear seems to be focused on pesticides and chemicals.

Neil Orloff, the Director of the Center for Environmental Research, pointed out in a recent Wall Street Journal article that, "people do not focus on a particular set of risks simply in order to safeguard health and safety. The choice also reflects their view of moral and immoral conduct."

William Allman gives this description of the General Public in a recent science '85 article:

"We the general public are irrational, uninformed, superstitious, even stupid. We don't understand probability are biased by the news media, and have a fear of some technologies that borders on the primeval." Before coming to this conclusion Allman gives some examples: "we smoke billions of cigarettes a year while banning an artificial sweetener because of a one-in-a-million chance that it might cause cancer, we eat meals full of fat, flock to cities prone to earthquakes, and go hang gliding while fretting about pesticides in foods, avoid the ocean for fear of sharks, and break into a cold sweat on airline flights."

Orloff believes that "the fear aroused by exposure to extremely low levels of pollutants in the environment far exceeds what available scientific evidence will justify. He suggests three reasons for this excessive fear:

1) The focus on pollutants provides a simple and plausible explanation for dreaded diseases such as cancer and birth defects.

2) Focusing on the risk of pollutants preserves peoples' image of the sanctity of nature.

3) Anxiety about pollutants provides an outlet for anti-big business feeling in the United States.

Regardless of the reason(s) for this fear of chemicals we cannot deny its presence nor its effect on society. For instance in Berkeley, California, city workers may use pesticides and herbicides only as last resorts and are even then restricted to four general use pesticides. Other restrictive measures on pesticide use are being proposed or passed throughout the country with more very likely as I'm sure you are all aware. In Wauconda, Illinois, treated buildings must be labelled and other municipalities are requiring prenotification.

How can this avalanche of public opinion be slowed or reversed? Louis Fernandex, Chairman of Monsanto, suggests that "we must double, redouble, and redouble again the amount of time and money we devote to educating the public." I agree that this is an approach well worth trying particularly with people who are already utilizing or considering your services. Frequently I receive calls at the office requesting information on the types of pesticides and their relative safety being used by lawn service and landscape maintenance companies. I feel that your operators should be thoroughly aware of what they are spraying on a client's lawn and should be able to supply your customers with that information. They should have labels and other related information at their disposal --either at their fingertips or at the very least a phone call away. Furthermore I would consider informing my clients in a newsletter of the pesticides you use and their safety - to the best of your knowledge. You might feel that this is inviting trouble but I contend that it is better to have a client who is aware of potential hazards--whether they be great or small--than to have one wondering what that smelly stuff is they are spraying on my lawn. Perhaps this frankness with your clientele will preclude more restrictive regulations.

To illustrate this point I'll quote some man-on-the-street interviews printed in the recent EPA Journal. 1) Delivering mail I come across a lot of yards that have been sprayed. You can always tell when someone has sprayed their yard because, you know, you can smell the pesticides on it."

2) The types of chemicals you put on your lawn has a great deal to do with the type of chemicals that end up in your water. The effect of these chemicals may not be known for 15 or 20 years and to what extent those chemicals cause cancer is unknown at the present time." People are wondering what we are using and if left to their own imagination they may perceive a threat where there is actually not any or very little.

One relatively simple way to illustrate the relative toxicity of the pesticides you are using is to prepare a chart comparing them to common household items. Using Vegetable Growing by W. E. Splittstoesser and the 1985 Farm Chemicals Handbook I put together such a chart. Here in ascending order of toxicity are a few examples.

RELATIVE TOXICITY OF SOME PESTICIDES AND COMMON HOUSEHOLD ITEMS

Material (Trade Name)	Oral LD_{50}
Slight Toxicity	
Benefin (Balan)	10,000
Benomyl (Tersan 1991)	10,000
Chlorothalonil (Daconil 2787)	10,000
Low Toxicity	
Iprodione (Chipco 26019)	4400
Low Toxicity	
Table Salt	3300
Aspirin	1300
Dicamba	1040
MCPP	930
Bensulide (Betasan)	770 (271-1470)
2, 4-D	375-805
Carbaryl	700
Moderate Toxicity	
Caffeine	200
Gasoline	150
Chlorpyrifos (Dursban)	97-276
Diazinon	80
High Toxicity	
Kerosene	50
Isofenphos (Oftanol)	28-38

In this chart relative toxicity is based on each chemicals oral LD_{50}. The oral LD_{50} is the quantity of chemical, in mg/kg that will kill 50 percent of the test animals (usually rats or mice) within a 14-day period after being administered by stomach tube.

Very seldom will the pesticide applicator be applying the pure active ingredient used in determining LD_{50} to a lawn. Most of the time it has been diluted to the point where the relative toxicity of the pesticide has been greatly reduced.

This brings to mind another truism to which we can pay lip service, the dose determines the poison. In other words there's nothing so toxic that in small enough amounts would not be completely harmless to a living organism; and there's nothing so safe that in large enough amounts would not be fatal to that creature.

Dr. Ottoboni points out: "every one of us ingests many lethal doses of many chemicals both natural and synthetic, during the course of a lifetime. A shocking thought! But consider, there is a lethal dose

of caffeine in approximately 100 cups of strong coffee. There is a lethal dose of oxalic acid in 10-20 pounds of spinach or rhubarb. There is a lethal dose of ethanol in a fifth of scotch, bourbon, gin, vodka, or other hard liquor. There is a lethal dose of aspirin in a bottle of 100 tablets. And the list could go on and on. The point of all this is that our bodies can handle small amounts of foreign chemicals, both natural and synthetic. We metabolize them or excrete them unchanged without their doing any damage. It is only when we overwhelm the natural defense of our bodies, by taking in too much at one time, or too much too often that we get into trouble."

In addition to being thoroughly familiar with the pesticides you are applying and their relative toxicity, you also need to be aware of some general statistics concerning pesticide use and safety.

In a 10-year period from 1973-1982 there were 54 fatalities in North Carolina which involved pesticides. Almost this many people die in auto accidents during any major holiday. Of these pesticide related deaths, half were intentional involving suicidal or homicidal acts. As John Wilson states, "2.7 average accidental deaths per year from materials as widely used as pesticides is not a bad record, but where human lives are concerned, we would wish and work toward zero." Even though pesticide poisonings are rare, I caution you to not disregard your clients' or in particular your employees' complaints about potential pesticide related illnesses. Sensitivities to pesticides vary among individuals. Be aware of the poisoning symptoms associated with the pesticides you are using.

Another fact you might use to reassure your clientele is that along with prescription drugs, pesticides are the most thoroughly tested and strictly regulated products on the market today. F.I.F.R.A. gives EPA authority to regulate pesticides and current estimates are it takes from 7 to 9 years and costs 30 million dollars to complete the registration process. Pesticides, as is true with any type of product, are neither inherently safe nor dangerous. The greatest potential for harm is in their misuse.

My purpose in presenting this talk to you are twofold. First I wanted you to know that we are not in an isolated pocket of the country which is not concerned about pesticide use and safety. Increasingly, at the Extension office, we receive inquiries concerning the relative safety of different pesticides. And as the local population grows in size and its roots are further removed from an agricultural emphasis I feel that there will be additional questions on pesticide use and even greater pressure to limit and legislate pesticide use on a local level.

There are numerous well-funded organizations dedicated to ridding our environment of synthetic chemicals and although we may feel they are misguided and purveyors of misinformation we cannot ignore them. For the general public no longer has the background or the inclination to make logical decisions based on scientific data. When dealing with pesticides often we are not in the realm of logic - we're in the Emotion Zone.

Second, I wanted to get you started in developing an appropriate

offensive posture before these organizations deliver the knockout blow. Educating your clientele is one of the things you can do and I've suggested some ways you might want to accomplish this. I'm sure you can come up with some better methods but I encourage you to initiate this educational process now.

More importantly you and your employees need to be thoroughly familiar with the pesticides you are applying and be prepared to answer any questions you may be asked concerning them.

In preparing this talk, I borrowed heavily from a number of sources. One I particularly liked is a book by Dr. M. Alice Ottoboni called The Dose Makes The Poison - A Plain Language Guide To Toxicity. This book is available through Vincente Books in Berkeley, California and is an invaluable reference source which I think should be required reading for any pesticide applicator and I encourage you to obtain a copy.

LAWN CARE PROGRAMS AND DROUGHT STRESS

Dr. Robert N. Carrow
University of Georgia, Griffin

Water is the most important requirement for survival and growth of the turfgrass plant. Thus, the lack of water can negate the effects of other cultural practices - fertilization, pesticides, and mowing. Even in the humid Southeast, periods of drought stress occur every year.

Drought is the lack of water that results in retarded plant growth and at least some death of tissues. There are three types of drought:

1. Soil drought - drought brought about by the lack of soil moisture.

2. Atmospheric drought - drought resulting from excessive atmospheric demand (i.e. low humidity, high temperatures, high intensity sunlight, wind) which exceeds the ability of the plant to provide soil moisture even though the moisture is available. Another cause of atmospheric drought is lack of a root system to take up the soil moisture.

3. Physiological drought - salt can induce drought. High salt content in the soil binds soil water and limits its availability to plants. Salt in contact with leaf tissues will remove water from the tissues until desiccation (salt burn) occurs.

Lawn care personnel should learn to recognize symptoms of drought stress. Symptoms vary depending upon the situation, but common ones are:

1. First stages of desiccation injury. Before desiccation occurs, the plant exhibits wilt symptoms. When wilt first appears, plant growth is reduced but the tissue has not been killed. At this stage:

*grass exhibits a bluish-green color
*leaves are rolled, folded, or drooping
*'footprinting' is evident since the grass does not have sufficient turgor to remain turgid after being stepped on.

Often these symptoms first appear in small areas. These areas can be used as indicators of impending stress on the remainder of the site.

2. Prolonged desiccation (drought) injury. As drought stress continues, the leaf tips start to dieback. Whole leaves are severely wilted, turn yellowish, and eventually die. The turf becomes yellow to light tan and thins out. Symptoms are first observed on sloped or thatched sites. Soils with high salt levels will also exhibit this type of injury.

3. Desiccation from fertilizer burn. Foliar application of nitrogen (N) can cause burn in some situations. The burn appears as leaf tip dieback. If severe enough, individual leaves, tillers or plants can die. Usually, the whole area is affected. Foliar burn from granular applications is evident in individual spots wherever the granules were in contact with plant tissue. On close cut, dense turf the individual, dime-size spots can be seen.

Lawn care programs could increase the potential for drought stress in several ways. Certainly, a well fertilized lawn will require ample irrigation. As N-rate increases, so does the need for irrigation if full benefit of the fertilization is to be achieved. Thus, homeowners should be encouraged to use an irrigation program suitable to their overall maintenance level.

Excessive N greatly promotes drought stress by decreasing root growth and drought hardiness. Deficient N will cause thin turf stands with little shading of the soil surface. This can result in excessive evaporation rather than plant transpiration.

Fertilizer burn by granular or foliar applications are probably the most common type of desiccation caused by improper lawn care programs. Fertilizer burn can be minimized by considering the following;

*use N-carriers with low salt indexes
*use delayed or slow release fertilizer formulations
*apply lower N-rates
*do not apply a granular with a high salt index to a dense turf, especially if dew is present.
*water after applications
*use higher rates of water

Foliar burn is most likely to occur when atmospheric demand is high and/or soil moisture levels are low. Thus, special precautions should be used at these times.

The lawn care personnel are often the primary sources of information on turfgrass maintenance for the homeowner. Thus, the lawn care company is wise to provide up-to-date, easy to read guidelines on how to irrigate and mow the turf. Both of these practices will markedly influence how well the turf will look, especially during moisture stress periods. For example, mowing too close and not irrigating sufficiently can cause a N-application to promote drought injury if applied just prior to the stress period.

As with any type of turfgrass management, the turf manager must learn to take a "systems" approach with the realization that any particular management practice can influence the "system" in many diverse ways. With lawn care, this system is complicated by having the management decisions divided between two managers - the lawn care company and the homeowner.

Insect Problems in Home Lawns

Dr. R. L. Brandenburg, NCSU

A recent survey in Virginia revealed homeowners place a very high value on a green, pest-free lawn. However, the survey results indicate most homeowners are relatively ineffective at insect pest management in their lawns. To effectively control home lawn insect pests, a plan to scout lawn areas for the presence of insects is essential. Once it is determined an economic infestation exists then proper application of an appropriate insecticide is recommended.

Probably the group of insects most frequently encountered by homeowners are bees, ants, and wasps. These are generally considered to be a nuisance although their digging can cover grass and cause moisture stress by loosening the soil. Vigorous, thick stands of grass will reduce homeowners' problems with these pests.

Many of the wasps are beneficial and chemical control should be avoided. However, should control of these pests be necessary, it is important to water in the insecticides following application. For digging wasp, a commercial aerosol spray can be directed in the next opening for good control. This should be done in the late afternoon.

A pest that has been on the increase in recent years is the green June beetle larvae. Homeowners frequently observe this pest crawling on patios, sidewalks, and other hard surfaces in the morning during September and October. This insect has the unusual habit of crawling on its back across the soil surface during the night. Although the larvae of the green June beetle does not feed directly on grass, it does damage turf through its extensive tunneling.

Control of this pest is fairly easy with insecticides if the chemical is properly applied. Since the insect crawls around on the soil surface, insecticides should be applied in 10 - 20 gals of water per 1000 square feet and <u>not</u> watered in.

White grubs that feed on grass roots are a troublesome insect throughout North Carolina. These insects are more difficult to detect and control than most other turf insect pests.

White grubs feed actively on the roots of grasses from late March until they pupate in June. Newly-hatched larvae feed from late July through early November. Insecticides are effective only if applied while the grubs are feeding in the root zone. Therefore, if grubs are present, insecticides should be applied in April or August to be most effective. It is important that these treatments be watered in thoroughly immediately after treatment.

Detection of white grubs can be accomplished by digging up a square foot "flap" of soil. Dig down on 3 sides of the square and then insert a shovel or spade about 4 inches under the soil and turn the sod back. Probe through the soil and roots and also down in the hole. Three to five grubs per square foot are enough to justify treatment.

Sod webworms are occasionally a problem on hybrid bermudagrass and chinch bugs on St. Augustinegrass. Insecticide application for these pests require that the chemical not be watered in. Sod webworms can be detected by mixing 1 oz of liquid detergent in one or two gallons of water and sprinkling this over a square yard area. Webworms will come to the surface in a few minutes. Five or more per square foot justifies treatment.

Chinch bugs can be detected in a slightly different manner. Insert a metal tube (i.e. a large coffee can with both ends removed) in the soil. Fill the tube with water and watch for chinch bugs to float to the surface. Twenty-five or more chinch bugs per square foot indicates a potential threat and treatment is advised. Irrigation often reduces chinch bug populations by promoting a fungal disease of the insect.

Although not an insect, earthworms occasionally are of some concern to homeowners. Generally considered a beneficial organism, they can become destructive when large populations are present. No currently recommended insecticides provide satisfactory control or suppression of earthworms.

ESTIMATING GROUNDS MAINTENANCE: LABOR COSTS

Allan Shulder, Executive Director
Professional Grounds Management Society

My talk today is supposed to be on estimating grounds maintenance jobs. However, due to the complexity of the subject and the time limitation, I am only going to address the labor costs in grounds maintenance jobs.

Labor constitutes the single most expensive item in grounds maintenance and is the one area where most estimating mistakes are made.

For example, if we estimate that a maintenance job will take four hours to complete with a crew of three laborers at $4.00 an hour and one foreman at $6.00 an hour, what would you estimate your labor costs would be for this job? One member of the audience came up with a $60.00 cost. He took his labor costs to be 12 manhours x 4, making $48.00, and one foreman at $6.00 an hour x 4 hours, making $24.00, for a total cost of $60.00.

Another member of the audience came up with the figure of $150.00. When asked how he arrived at that figure, he explained that he added what he called a labor burden. This is exactly what I wanted to hear from the audience to show the variance of estimating labor costs.

Most people do not figure many things into their labor costs. One very important item when you are in business is to add a profit margin. Another important item is to figure productivity.

A crew reports at 7:00 a.m.: there is no way that this 4-hour job will be completed by 11:00 a.m. It has been shown by many surveys that the national average of production time in an 8-hour day is between 4½-5 hours. Many other costs in estimating labor must be figured.

If you figure that you are paying a man throughout the year, such as a key employee, you probably pay for 10 holidays, 12 vacation days, 6 sick days and 2 miscellaneous days for which he therefore gets 30 days paid leave a year. Figure 52 weekends at 2 days each for 104 days. This makes a total of 134 non-working days, leaving a total of 231 working days a year.

If you figure a production time of an 8-hour day at 6 hours (which is higher than the national average), you will come up with a total of 1,386 hours of productive time per year.

You also have to add in fringe benefits, overhead and profit. So you can see that you must charge well over the $6.00 per hour for this foreman.

Many other costs enter into your labor costs. Some employers pay bonuses. You must, of course, add in the employer's share of social security, a share of overhead, federal and state unemployment insurance, and workman's compensation. Other expenses might also include life insurance, health insurance, uniforms, and many other fringe benefits.

If I have only gotten the point across that you must estimate your labor carefully and add in all your unseen costs, my talk would have been worthwhile.

DISEASES TO ANTICIPATE IN LAWNS IN 1986

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Many different diseases occur in lawns throughout North Carolina each year. The diversity of the turfgrasses grown in North Carolina contributes to the large number of diseaes that might occur. Cool season turfgrasses such as bluegrass, ryegrasses and fescues are used in the western portion of the state. Warm season turfgrasses such as bermudagrass, centipedegrass, St. Augustingrass, zoysiagrass, bahiagrass and carpetgrass are used in the eastern protion of the state. All of these turfgrasses are used for lawns in the central portion of the state. Even some cool season turfgrasses such as ryegrasses are used as overseeding grasses in bermudagrass lawns in the east. The zones of adaptation in the state are equivalent to growing turfgrasses in the northern states in the northwestern corner and in the most southern states in the southeastern corner. Therefore, the turfgrasses and diseases that occur in North Carolina are similar to turfgrasses and diseases that occur from New York to Florida.

Certain diseases can occur any time of the year on cool season grasses in the state. The first disease that might develop would be pink snow mold that often occurs in the western and central portion of the state during extended periods of cold, wet weather during the winter. This disease causes small circular patches in which the grass dies quickly. Grass that has been fertilized with heavy rates of nitrogen is more susceptible to pink snow mold. Therefore, do not use excessive rates of nitrogen in the fall. A fungicide may be needed in the fall if the disease has been severe during previous years. Cool-weather brown patch, or yellow patch, is a relatively new disease that has developed during cool, wet weather in recent years. Circular brown to yellow areas develop and the symptoms usually remain until the grass begins growing in the spring. Young seedlings appear to be damaged more than older plants and more damage occurs when grass has been fertilized heavily with nitrogen. Plant seeds between September 15 and October 15 and avoid using too much nitrogen in the fall. The next disease to anticipate on cool season grasses is Helminthosporium leaf spot during cool, moist weather in the spring. This disease usually does not cause severe damage at this time of year but may cause the turfgrasses to become weak and thin during the the summer stress period. Control with a fungicide usually is not

needed and a good management program to produce a good healthy turf will usually help overcome this disease.

Brown patch is the most serious disease of tall fescue in the central portion of North Carolina during the summer and fall. This disease begins as small circular brown patches when the weather becomes hot and humid, usually in June. More patches may develop and the older patches may continue to enlarge up to four to six feet in diameter during the summer. The disease may spread throughout the lawn by the end of the summer resulting in uniform brown appearance without distinct brown patches. Lesions that are a darker green develop on the leaves during moist or wet weather. The leaves may be girdled, die rapidly and become light tan when they dry. Webby mycelium of the fungus that causes the disease may be seen on the leaves in the morning or during extended periods of humid weather. Vigorously growing plants that have received higher than recommended rates of nitrogen fertilizer during the spring and summer are more susceptible to the disease than properly managed turf. Tall fescue that was planted the previous fall or in the spring is more susceptible to brown patch than older plantings. Well-established lawns that have been properly managed may be damaged by brown patch, but the grass will usually recover during favorable growing weather in the fall. Adjustment of the soil pH to near 6.5 during establishment is an important management practice that will help control brown patch. Soil test information should be used to determine how much lime is needed and it should be worked into the soil before planting. Nitrogen fertilizer should be applied in the fall, winter and spring. Very little, if any nitrogen, should be used during the summer to help reduce the severity of brown patch. If the lawn is irrigated, it should be irrigated about once a week during dry weather and enough water should be applied to wet the soil about six inches deep. Frequent, light irrigations will encourage the development of the disease. Fungicides can be used to control this disease, but the cost is usually more than the home owner is willing to pay. The fungicides should be applied about every 3 weeks during warm, moist weather and the difference in turf quality between treated and untreated areas is usually not different later in the fall when proper management is used.

White patch is a disease that has been observed in recent years on tall fescue. It develops most often in one to two year-old lawns that have been established in recently wooded areas. This disease produces small circular white patches, usually during very hot and humid weather. Small tan mushrooms (about 1/4 inch in diameter) develop on some of the dead leaves. The tall fescue may become thin in the affected patches but usually enough plants survive and grow in the fall to fill in the spots. Proper fertilization, particularly proper soil pH

during eatablishment, appears to help prevent this disease. The disease usually disappears after the turf is three years old.

Red thread is the disease that occurs most frequently during the summer on bluegrass in the mountains. The symptoms of this disease are small circular brown patches similar to brown patch. A small "red thread" of the fungus that causes this disease can be seen at the end of some of the dead leaves and is used to identify red thread. This disease usually develops on bluegrass that is deficient in nitrogen. An application of nitrogen fertilizer will usually help the bluegrass overcome the disease because the diseased leaf tips will grow out and be mowed off. Certain fungicides can be used to control this disease, but usually are not needed with proper management.

Rust is a serious disease on some older bluegrass varieties. The symptoms of rust begin as small yellow flecks on leaves that enlarge into red to brown raised spots that contain masses of microscopic spores. Symptoms may be similar to Helminthosporium leafspot except that leafspot leisons do not have raised centers. Rust infected leaves turn yellow and die slowly giving the turf a uniform yellow to brown color in late summer. The bluegrass will become weak and is more susceptible to drought stress and weed invasion. The best control of rust is to use new improved varieties that are more resistant to the disease. Certain fungicides can be used to control rust and may be needed to maintain a stand of some of the older varieties.

Drought and heat stress can damage both tall fescue and bluegrass. Lawns that were planted the previous spring are more susceptible to this damage than older lawns. Irrigation is needed to help turfgrasses survive in lawns that are less than one year old. Drought and heat stress is usually more severe on open slopes that face the to the south and west in the transition zone. A warm-season turfgrass may provide a better turf on these areas in this zone. High soluble salts from too much fertilizer is often a problem when fertilizer is applied during dry weather. The grass may wilt and have a yellow to tan color a few days after fertilization if salts in the soil are too high. Large amounts of irrigation water or rain will be needed to leach the salts deeper into the soil and to provide sufficient water for the turfgrass. Fertilizer should be applied at proper rates and the lawn should be irrigated after the application if the weather has been dry.

Animal urine can cause serious damage to tall fescue during dry weather. The symptoms are a few circular areas that die quickly and later are surrounded by darker green and fast growing grass. All of the tall fescue plants may be killed and since this turfgrass plant does not have underground rhizomes or

stolons, it does not grow back into the spot. The turf usually becomes patchy and weeds invade the dead areas. The best way to avoid this damage is to keep the animals out of the area. If animals are kept in the area, damage can be reduced by keeping the lawn irrigated to dilute the soluble salts in the urine.

Diseases can be severe on recently seeded tall fescue lawns during the fall. Seeds should be planted after the weather has become cooler in September of October. Brown patch can kill many of the young seedlings if the weather remains warm and moist in October or November as occurred in 1985. Broad spectrum fungicides can be used to control these seedling diseases, but good management will usually give satisfactory control. Reseeding in the late fall or early spring may be useful if a large percentage of the seedlings were killed.

The first problem observed on warm-season turfgrasses in the spring is usually cold damage. The symptoms appear as these turfgrasses begin greening-up in the spring as large irregular areas that do not grow or sometimes the whole lawn may be dead. The damage is more severe following very cold winters or following springs with periods of unusually cold weather. Fertilization the previous summer and fall with higher amounts of potash and irrigation during very dry winters will help prevent cold damage. If the turf was damaged severely, replanting as early as possible in the summer will help the lawn recover faster and prevent weeds from becoming a serious problem.

Spring dead spot is the most serious disease of bermudagrass and is observed as the bermudagrass resumes growth from winter dormancy. The symptoms are small circular dead spots from 1/2 to 2 feet in diameter. The disease usually develops after the turf is 3 to 4 years old and many of the spots occur in the same spots for 3 to 4 years. The spots usually enlarge during this time and have a ring of dead grass with live grass in the center during the third and fourth years. The bermudagrass grows over the spots slowly during the summer and weeds often invade the spots. High levels of management that uses high rates of nitrogen fertilizer encourages the development of spring dead spot and unlike many other diseases, it often is a problem on the best manintained bermudagrass lawns. The disease is often more severe following very cold winters. It occurs in the northern range of adaptation of bermudagrass which has a colder climate. This disease can be controlled with the fungicide, Tersan 1991, but it must be applied in the fall around November 1. This treatment is expensive and only areas that had the disease the previous spring should be treated. A management program that uses lower rates of nitrogen and higher rates of potash should help reduce the severity of spring dead spot.

Brown patch of bermudagrass has been observed on bermudagrass during wet weather in the spring and early summer in recent years. The symptoms of this disease are large circular brown patches that are from 3 to 20 feet in diameter. It occurs most frequently on hybrid bermudagrass such ar Tifton 419. Fungicides have not given good control of this disease. The bermudagrass grows out of this disease when the weather becomes hot and dry and fungicides probably are not needed.

Gray leaf spot can be a serious disease of St. Augustinegrass during the summer. The symptoms are numerous small gray spots on the leaves. The disease may continue to develop during moist weather until the turf has a brown color and the turf may become thin. High rates of nitrogen fertilizer makes St. Augustinegrass more susceptible to gray leaf spot. Broad spectrum fungicides can be used to control this disease, but a management program that uses low rates of nitrogen will ususally prevent it from causing serious damage.

Rust can be serious on zoysiagrass particularly where this grass is growing in partical shade. Leaves infected with rust will have a yellow to orange color from the masses of microscopic spores that are produced by the fungus that causes this disease. The combination of shade and the disease will cause zoysiagrass to become thin after several years. Certain fungicides can be used to control this disease, but a good management program and the removal of shade is the best means of control.

Centipede decline is the name given to a serious problem that occurs on centipedegrass. Research has shown that several factors, or a combination of factors, are involved in the development of centipede decline. Damage from cold weather is usually the first problem that is observed in the spring. However, the grass usually recovers very slowly and may continue to die during the summer. The use of higher than recommended rates of nitrogen fertilizer the previous summer has been the factor most often associated with this problem. Not more than 1/2 to 1 pound of actual nitrogen per 1000 square feet should be used each year on centipedegrass. More nitrogen fertilizer than this will cause an excessive amount of thatch to accumulate and the grass will be less tolerant to cold weather. Low levels of potash in sandy soils has also been associated with centipede decline. This nutrient helps the grass tolerate the stresses of drought in the summer and cold in the winter. Therefore, a fertilizer low in nitrogen and high in potash, such as 5-10-30, is suggested for centipedgrass and should be applied in early summer. Nematodes are often associated with the decline of centipedegrass in sandy soils during very dry summers. The sting nematode causes the most damage, and good quality centipedegrass cannot be grown when this nematode occurs at high levels. The

namaticide, Mocap, is registered for use in home lawns by licensed applicators. This chemical is very toxic and should be used only when good management and irrigation practices will not result in a good turf. Fairy rings appear as circular green or dead areas in lawns and are especially severe on centipedegrass. The circles may be from 3 to 25 feet in dameter with heathly grass in the center or sometimes the entire circle may be dead. The rings enlarge from 1 to 2 feet each year and may be continue to enlarge for many years. Fairy rings have been difficult to control. The best and most practical control has been obtained when the affected area and at least one foot of the surrounding healthy turf has been rototilled and the area replanted with healthy grass. Ground pearls is an insect problem that occurs in circular patches and can resemble fairy rings. This insect is identified by the very small "pearl-like" structures that are attached to the roots. Chemicals are not available to control this insect. A good management program or even an alternative grass such as bermudagarass may help overcome the effect of ground perals. Centipedegrass is very sensitive to some commonly used herbicides, the use of these chemicals at rates higher than recommended for centipedegrass often is associated with the decline. Centipedegrass has been shown to survive best when it is mowed at about 1 inch. It tends to accumulate more thatch and is more susceptible to winter damage when it is mowed higher. Several diseases such as brown patch and dollar spot may occur on centipedegrass, but have not been demonstrated to cause severe damage in North Carolina. The most important factor to help prevent centipede decline is to fertilize properly, and remember that centipedegrass grows and survives best with lower levels of nitrogen than other warm-season turfgrasses.

Fairy rings and too much shade are problems that occur on all of the warm-season turfgrasses during the summer. Fairy rings usually cause large green or dead rings in bermudagrass but usually do not cause as much damage as in centipedegrass. The warm-season turfgrass are not very tolerant of too much shade. As trees in lawns grow over the years, more shade is present and these grasses do not grow as well. Lower limbs or ever entire trees should be removed to allow more sunlight to reach the grass. Another alternative is to develop a landscape plan to convert turfgrass areas into ground covers or use mulch in shady areas.

Many of the diseases that have been discussed above can be expected to occur in 1986. Turf managers should be aware of these diseases and be able to identify them quickly to help avoid serious damage. Additional information can be obtained in publications such as the Turfgrass Pest Management Manual and the Pest Control Recommendations published by N. C. State University or from your local Agricultural Extension Agent.

LANDSCAPE MANAGEMENT IN WINSTON-SALEM

Daryl Siefert
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As Landscape Planner for the City of Winston-Salem I am responsible for the design, installation and maintenance of most landscaped areas throughout the City. Although I am a member of the Parks and Recreation Department, my responsibilities extend far beyond just park properties.

The City of Winston-Salem covers over 70 square miles. Within the city we have 60 parks totaling approximately 3,000 acres. In the parks we mow and maintain 350-400 acres of turf. In addition to the park properties, we maintain 275 shrub beds; 25 flower beds; 5,000 roses along our expressways; 50,000+ street trees and over 20 miles of exercise trails. Our work force responsible for these tasks consists of 35 permanent people with an additional 10-12 temporary people added during peak seasons. This work force is broken down into the following crew compositions: 2 tree crews, 1 mowing crew, 1 rose care and specialty crew and 3 general duty landscaping crews.

Due to the sheer volume of work that we have to perform, it is impossible for us to assign each job a top priority rating. In many cases we maintain areas at what we consider an "acceptable level". The watching eyes of 135,000 citizens helps us determine what these acceptalbe levels are. In order to determine our maintenance schedules we have broken our total workload into 4 major categories: turf maintenance, shrub bed maintenance, tree maintenance, and specialty projects. The work within each category is then prioritized based on such factors as visual impact, degree of usage, age of the planting and public comment.

I would now like to run down through the priorities for each major area and the actual maintenance levels performed. Our 1st. Priority turf areas consists of places such as City Hall, Public Safety Building, several downtown parks and Bowman Gray Football Stadium. These areas are mowed twice weekly. They are also fertilized, aerated and overseeded twice yearly. Insect, weed and disease problems are handled on an as needed basis. Most of these areas have Rebel hybrid fescue turf except for Bowman Gray which is a bermuda field. Most of these areas also have automatic irrigation systems. The 2nd. Priority turf areas are areas such as lighted athletic fields and areas around out-lying buildings. These areas are mowed once a week with tractors and rotary mowers. We aerate, fertilize and overseed one time a year. There are no disease or insect control measures, but we are hoping to implement a weed control program. Grass type is primarily KY 31 fescue. The 3rd. Priority areas are unlit athletic fields, general purpose park grounds and out-lying areas. They are mowed once every two weeks with tractors and rotary mowers. Fertilization and overseeding are done on a limited basis as budget and time permit. No disease, weed or insect control programs are practiced.

Our shrub bed program is also divided into 3 priority systems. Comprising the 1st. Priority are all beds in the downtown area. These beds are viewed by large volumes of pedestrian and slow moving vehicular traffic. All newly installed beds are also top priority for two years until they are fully established. These beds are worked every two weeks by a crew. Standard maintenance practices such as weeding, mulching, pruning and spraying are practiced. The 2nd. Priority beds are those around city facilities and recreation centers. Beds located on highly traveled parkways are also included. These beds are worked once a month. The same maintenance functions

as for top priority beds is practiced. Our 3rd. Priority beds are those located in out of the way locations. Most shrub beds in city parks, those on lightly traveled roads and cul-de-sacs or those on high speed expressways are in this category. A crew works these beds once every 6 weeks. The same maintenance procedures as for other beds are practiced.

The tree maintenance program encompasses both newly planted young street trees and existing mature trees. All new trees have 1st. Priority status. Work on these includes watering, fertilizing, re-guying and mulching if necessary. All downtown street trees, trees around primary city buildings, as well as trees along heavily traveled boulevards are also top priority. These trees are dead-wooded and limbed-up on a yearly basis. Service requests or complaints are handled within one week or sooner depending on the particular situation. Most of the street trees throughout the city fall into our 2nd. Priority. We have divided the city into four quadrants and the trees within a particular quadrant are pruned and dead-wooded within a given year. This 4 year rotation has been hard to stick to because we are constantly pulling off of this work to take care of more urgent problems. The addition of a third tree truck in next years budget should help this routine maintenance program.

The last area of responsibility is a broad one that I have labeled specialty projects. Within this area are such diverse items as roses, flowers, bulbs, exercise courses, greenways, new city buildings or special construction projects. Some of these such as roses and flowers carry a top priority and are worked on a regular basis. Others such as bulbs and new construction tend to be a one time deal. Still others such as the exercise trails are worked on an as-needed basis or when a complaint comes in.

As in any maintenance schedule, constant changes and adjustments are made. Our primary goal is to have those areas foremost in the eyes of the public maintained in a neat, aesthetically pleasing manner. Unfortunately, some lesser seen and used areas suffer to accomplish this goal. Hopefully we are able to maintain a proper balance and no areas go unattended. As with any maintenance program, there is more involved than just the day to day care. A properly maintained landscape starts with a practical plan, followed by correct installation and is completed with a comprehensive maintenance program. As grounds managers it is our task to co-ordinate all of these elements so that the landscape achieves its intended goal.

IT'S NEVER TOO LATE--REMEDIAL LANDSCAPING

M. A. Powell
Extension Landscape Architect
North Carolina State University
Raleigh, NC 27695-7609

> Landscape architecture is primarily a fine art and as such its most important function is to create and preserve beauty in the surroundings of human habitations and in the broader natural scenery of the country; but it is also concerned with promoting the comfort, convenience, and health of urban populations which have scanty access to rural scenery and urgently need to have their hurrying work-a-day lives refreshed and calmed by the beautiful and reposeful sites and sounds which nature aided by landscape art can abundantly provide.[1]

Landscape design is concerned with the development of the total living environment of man. All of our communities need more properly organized space or better organization of existing spaces. The average person lacks vision in landscape design. He focuses on the short-term effects rather than the long-term contribution the landscape can offer.

Most landscapes have poor relationships between indoor and outdoor space. Plant material is often the only component used by many "landscapers." The arrangement, as simple as it may be, is either a combination of many plants or an overuse of a few into a meaningless space. The grounds keeper is often overwhelmed with the general maintenance requirements--pruning, fertilizing, mowing, watering, etc.--associated with a properly designed landscape to fully appreciate the real contribution. In the development of grounds for use and beauty, the landscaper must organize ground forms, structures and plants into an overall pleasing composition that satisfies the accepted principles of art such as unity, rhythm, variety, balance, sequence, scale, and emphasis.

As one critiques a given space--from the eyes of a designer--one realizes it is NEVER TOO LATE to remodel the landscape. Don't be satisfied to simply prune overgrown misplaced shrubs--remove, redesign, and recreate.

---

[1]Charles Elliott, former president of the American Society of Landscape Architects.

Centipedegrass for Low Maintenance Areas

W. B. Gilbert
North Carolina State University

Centipedegrass is a slow growing, yellow-green, coarse-leaf turfgrass that is adapted for use as a low maintenance, general purpose turf. It requires little fertilizer (1/2 pound per 1000 square feet of nitrogen per year), infrequent mowing and grows well in full sun to moderate shade. It does not tolerate traffic, compaction, high phosphorus soils, high pH, low potassium soils, excessive thatch, drought or heavy shade.

Centipedegrass is susceptible to a number of pest related problems. Symptoms include small circular dead areas after several years of good performance. Areas do not green up in the spring or begin to die in late spring or during drought stress. Grass at the edge of affected areas may yellow, wilt and die. Possible causes include nematodes, ground pearls (an insect) and fairy ring (a fungus). Injury from certain broadleaf weed control herbicide and mismanagement also can be confused with pest problems.

Winter Injury of Centipedegrass

Centipedegrass is a stoloniferous grass, spreading with above ground runners (stolons). These stems have a high lignin content and do not decompose readily, thus developing a thatch layer. The rate of thatch accumulation is a direct result of management practices which provides abundant vegetative growth. Excessive nitrogen fertilization and a high mowing height encourages thatch buildup after very few years. The subsequent growth of new runners are soon several inches above the soil surface and are exposed to the severe fluctuations of temperatures as normally experienced in late fall and winter. This results in winter kill of irregular patches that has been labeled "Centipede Decline." The following table illustrate the causes:

Centipedegrass Study 1966. N. C. State University

N rate/month June and August	% Winter Kill Height of cut	
	3/4"	2"
0	5	20
1/2	9	28
1	15	45
2	32	85

The "Centipede Decline" may be influenced by disease and/or nematodes. A study was conducted in 1976 by Gilbert and Lucas to investigate a systemic fungicide (Tersan 1991); a nonsystemic fungicide (Daconil 2787); and a nematicide (Dasanit). These were coupled with nitrogen rates.

Centipedegrass Study 1976. N. C. State University

Chemical	Quality		% Winter Kill	
	Lo N	Hi N	Lo N	Hi N
A. Tersan 1991	8.0	6.0	12	32
B. Daconil 2787	7.6	6.3	12	27
C. Dasinit	6.6	6.0	18	32
D. Check	7.3	6.3	20	33

Rates: Lo N = 1/2 lb N/M June and August; Hi N = 1 lb N/M June and August

A. = 4 oz/M/Mo; B = 8 oz/M/Mo; C = 5 lbs/M/Yr

The fungicides and nematicide had very little effect on quality, with a minor effect on winter kill. The high nitrogen rate plots had lower quality and more winter kill than the low rate.

Performance of Centipedegrass in Highway Adaptation Trials

Rating	County Locations*															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date	Percent cover															
Sept. 1981	85	13	0	7	37	55	28	75	98	3	82	87	72	22	0	75
Aug. 1982	93	33	5	17	37	65	40	85	90	0	43	93	72	32	0	82
July 1983	92	58	7	12	43	70	38	43	77	0	82	48	63	28	2	85

Seeding rate: 13 pounds/acre
Seeding dates: March-June 1980 (starting 1 through 16)

*1. Brunswick; 2. Chowan; 3. Carteret; 4. Martin; 5. Nash; 6. Bladen; 7. Moore; 8. Granville; 9. Rockingham; 10. Davie; 11. Mecklenberg; 12. Catawba; 13. Wilkes; 14. Yadkin; 15. Buncombe; 16. Jackson.

Centipedegrass is more widely adapted to North Carolina than previously believed. The adaptation zone includes the Piedmont as well as the Coastal Plain, with the Mountain region being categorized as an area of poor adaptation. Yet two of the three locations in the Mountains maintained excellent stands. This apparent contradiction is likely explained by the cold tolerance characteristics of this species. Centipedegrass rapidly reduces its cold hardiness with the onset of warm

weather in late fall and winter. Poor field performance of centipedegrass was essentially restricted to the trials in Davie and Buncombe counties. In each of these locations winter conditions have typically included warm periods followed by very cold air temperatures. Such weather patterns may then predispose centipedegrass (and other warm season turf species) to winter injury. Centipedegrass stand survival in the trials at Jackson (85%) and Wilkes (63%) may have been due to colder temperatures at these elevations during warm spells compared to the Davie and Buncombe tests.

The Carteret trial never became established due to the very sandy nature of the soil and strong competition from sawbriers. Out of 24 species planted, only weeping lovegrass had an acceptable stand.

Establishment Studies

Since centipedegrass is somewhat slow in becoming established, a greenhouse and field study were initiated with "nurse crops" of tall fescue and weeping lovegrass seeded with centipedegrass at various rates. The term "nurse crop" refers to a plant that will establish itself quickly and provide initial soil erosion control until a more desirable "permanent crop" has time to fully establish. The desired characteristics of a low maintenance permanent crop species includes: a) the ability to adapt to poor soils and adverse environmental conditions, b) disease and drought tolerance, c) reduced mowing and fertilization requirements, d) the ability to reestablish itself quickly (recuperative potential) and e) provide adequate soil erosion control.

Tall fescue has been a satisfactory permanent crop for use along North Carolina roadsides, but has certain undesirable characteristics from a low maintenance perspective. These include: a) relatively fast growth and frequent mowing requirements, b) moderate heat and drought tolerance and c) slow recuperative potential. The use of tall fescue as a nurse crop could be beneficial since it establishes from seed in 7 to 14 days and seed is relatively inexpensive.

Weeping lovegrass is drought tolerant and has no significant disease problems. Establishment has been satisfactory in soils with pH values in the range of 4 to 6. Weeping lovegrass has a tendency to clump and thin out in 2 to 3 years. Seeded as a nurse crop, this tendency could provide an opportunity for the establishment of a more desirable permanent crop.

A permanent crop such as centipedegrass, once established, could provide soil erosion protection under minimal maintenance conditions. Centipedegrass has received relatively little attention as a roadside cover, but is commonly used in lawns throughout the southern sections of the state. Despite high seed costs (approximately $25 per lb) and its slow growth rate, centipedegrass could be economical in the final analysis. Centipedegrass is one of the lowest maintenance turfgrasses adapted to North Carolina as it establishes and maintains itself well in soils with a pH range of 4 to 6, has good recuperative potential and is fairly cold tolerant along with an ability to withstand heat and drought stress. Centipedegrass has a much reduced mowing requirement due to its low growth

habit and short seed stalks.

A greenhouse study was initiated in October 1980 to examine the establishment of lower maintenance grasses. A randomized complete block design was used with mixtures of the permanent crop (centipedegrass) and nurse crops (tall fescue and weeping lovegrass) at four seeding rates. Centipedegrass was seeded at 20, 10, 5 or 3 pounds per acre. Weeping lovegrass was seeded at 15, 8, 4 or 2 pounds per acre, while tall fescue was seeded at 79, 37, 19 or 9 pounds per acre. The highest seeding rate was from 0.5 to 0.25 of the rate normally used on roadsides.

A similar field study was initiated in June 1981 in Bladen County adjacent to the plant evaluation trial. Weeping lovegrass was not included due to its competitive nature. The seedings rates were the same for tall fescue and centipedegrass in the greenhouse study. Excellent stands of both were obtained the first year, with no maintenance fertilization or mowing being done. In July 1985 the plots were evaluated with 100% of the stand being centipedegrass. There was no difference in the density of stand between seeding rates, indicating a very low rate of centipedegrass (3 pounds per acre) was sufficient when seeded with tall fescue as a nurse crop.

The most striking feature in the plots was the absence of foreign plants. Adjacent areas that had been tilled and seeded to tall fescue and bahiagrass were approximately 75% broomsedge and other weedy species. It is thought the centipedegrass had an "allelopathic" effect on other plants. Allelopathy is defined as a biochemical inhibition between higher plants caused by the release of various metabolic substances. If the absence of other species is due to allelopathy and not to a dense competitive stand, the use of centipedegrass for low maintenance areas is even more promising. Additional research is planned to investigate this possibility.

TURF RELEASE AND WEED CONTROL ALONG ROADSIDES

Dr. W. M. Lewis
North Carolina State University
Raleigh, NC 27695

Long term evaluations have shown centipedegrass to be adapted to roadside conditions in NC. Therefore, we were interested in releasing it from the competition of other turf grasses as well as weedy grasses. We evaluated a number of postemergence grass herbicides which are available or potentially available for use in field crops. Of the grass control herbicides tested, Poast effectively controlled bahiagrass and tall fescue without injury to the centipedegrass. Also we found that centipede was tolerant to Oust which is a non-cropland herbicide. Centipede is tolerant to multiple applications of Poast 1.5E at 0.2 and 0.3 lb active per acre and to Oust 75 DF at 0.75 and 1 ounce active per acre. For the control of the bahiagrass, Poast was most effective when two applications were spaced four weeks apart while Oust was most effective when the applications were spaced two weeks apart. The treatments were also effective in controlling tall fescue, crabgrass and goosegrass and in suppressing bermudagrass.

Broomsedge is a very unsightly plant along highway roadsides. Postemergence herbicides were evaluated for the control of broomsedge at the same time we hoped to be able to find a herbicide which would also be tolerant to tall fescue and bermudagrass. We are surprised to find that MSMA can effectively control broomsedge. One application of MSMA applied July 17th at 2 lbs active per acre was very effective. Two applications at the same rate spaced 12 days apart were only slightly more effective. We obtained 85 to 95% control of broomsedge which was 8 to 10 inches tall at the time of the spraying.

These herbicide programs will be helpful in maintaining our highway roadsides in a more eye appealing condition.

EROSION CONTROL AND SOIL STABILIZATION TECHNIQUES

W. D. Johnson
Landscape Unit
North Carolina Department of Transportation

The Landscape Unit on the Division of Highways, Department of Transportation is responsible for erosion and sedimentation control, along with the techniques that are necessary to prevent off-site sedimentation and allow for the permanent stabilization of our roadsides.

The Sedimentation Pollution Control Act of 1973 controls land disturbing activities by state law and allows for penalties and civil action against those who cause off-site sedimentation damage. The Division of Highways operates under a blanket permit for construction and maintenance operations because of our in-house plan preparation and inspection programs.

We begin our process of installing temporary erosion control measures in the clearing and grubbing stage of a project. Our Unit prepares temporary erosion control plans in the planning stages of the project and these are then implemented beginning in this stage. It is very critical to get ahead of erosion and sedimentation with your measures. Playing catch up in this game can be disastrous.

One of the most critical sites on any land disturbing project is a live stream crossing. We put special emphasis on temporary erosion control at these sites. These may be pipe or major culvert crossings or even bridge sites.

One of the items that we have used extensively and that has served very well is silt fence. This is simply metal or wood posts with hog wire with a burlap lining fastened to the hog wire, usually with seat cover rings. Also, many new man-made fabrics are now being used in place of burlap. The main one that is being used on our projects at present is a woven polypropylene. Silt fence can be used at the toe of fill slopes and also in ditchlines to slow the water and allow the sedimentation to filtered out. We also use it to surround drop inlets, normally in median sections.

Another temporary erosion control item we use extensively is check dams. We have several variations of this, including a small brush dam which is supported by two vertical poles and several horizontal poles running across the drainage way with usually pine boughs placed on the upstream side. We also have a heavier type dam that utilizes poles driven vertically into the ground, all the way across the drainage way with boughs across it. One of the better dams now in use is our rock check dam built simply by dumping rip rap or erosion control stone across the drainage channel and forming an outlet across the middle. Any of these check dams work much better with a silt basin dug on the upstream side to allow for storage of the silt that settles out.

We use many variations of silt basins, or settling basins, including small basins constructed in a ditchline dug with a backhoe which simply is an area for the silt to settle into or larger basins dug with a dragline to allow for drainage to pass through and more settling time. We even construct large pond type basins that utilize a perforated riser and emergency overflow channel for even larger drainage areas. In constructing silt basins you should remember to maximize the length of the basin, as this allows for more settling time. A short, squatty basin is not of much value.

In some instances, the use of a silt ditch may be appropriate which is simply a ditch pulled along the toe of a fill slope with a silt basin, usually at the outlet end, to catch sediment that might come off the face of the fill slope.

In fill slope stabilization, one of the main considerations we need to be aware of is taking water from the top of the fill and transmitting it down the fill without causing erosion. We do this by the use of flexible slope drains using corrugated plastic pipe, (12" in diameter). A berm should be pulled on the top of the fill slope and then these flexible pipes placed along the fill slopes laying on top of the slope. The number would depend on drainage area. You should remember to stabilize the mouth area of the flexible pipe which must be cut into the berm to allow for the inlet water. We have used stone and erosion control matting for this purpose.

With regards to permanent erosion control we are looking to grasses and legumes for this purpose. In establishing grasses and legumes, we have found that on the soil types we deal with, which is usually some portion of the subsoil, that seedbed preparation is probably the most important item involved in permanent erosion control. Our specifications call for a 5" seedbed and, of course, 6" would be better. Many times you have seen initially a good stand of grass deteriorate and die in the hot summertime. Usually this can be related back to a poor seedbed, probably 1"-2" which didn't allow for deep root penetration.

We apply, generally, two tons per acre of agricultural limestone to all seeded areas. We developed this specification after taking statewide soil tests and found that generally we are dealing with acidic soils across our state, particularly these subsoil portions and have a need for this much limestone. Limestone is applied by both bulk operation and by the use of bagged lime depending on the size of a project and the slopes involved. As you are aware, incorporation of the limestone the full depth of the seedbed is important.

Fertilizer is another important item in the permanent seeding operation. We are using a 10-10-20 analysis fertilizer for initial establishment and a 16-8-8 fertilizer for topdressing operations during the life of our projects. Utilization of these analyses were also based on soil test information on a statewide basis.

Seeding operations along our roadsides are carried out utilizing several pieces of equipment, sometimes a grain drill or cyclone

seeder in the east and usually a hydroseeder in our upper piedmont and mountainous areas.

One of the most important items to our success in permanent seeding is mulching. We utilize grain straw and feel that is very critical to get a good mulch cover for both erosion control and to aid in the germination and establishment of the grass or legumes. We tack our mulch generally with asphalt to hold the straw in place.

We also have used on some of our old eroding cutslopes hardwood bark, blown on by an Estes blower which is mounted on a bulk truck unit that DOT owns. The process involved here is hydroseeding these old slopes with lime, fertilizer and seed and then blowing the hardwood bark on at the rate of 35 cubic yards per acre. We have an excellent success with this method and generally are using it as a spot treatment statewide to cover some of these old eroding cutslopes.

Ditch stabilization is, of course, a very important item with regards to erosion control. We have utilized, over the years, several materials for ditchline stabilization including:

1. Jute matting - a woven burlap type matting that has worked fairly well if you have a good flat seedbed.

2. Excelsior matting - constructed of wood strings and a nylon mesh grid formed into a mat. Excelsior has worked very well over the years and allows usage for more uneven terrain than jute mesh.

3. Hol Gro - a paper type mat, has not been very successful as the mat does not deteriorate and gives a plantbed cover effect.

4. Enkamat - man made 3 dimensional mat, which works very well, but is very expensive.

5. Fiberglass Roving - mat formed from a spool of woven fiberglass which is drawn through a nozzle and blown out by air pressure. The strands separate and you have what looks like angel hair on the ground which does an excellent job of covering uneven terrain. We then tack this fiberglass with asphalt to form the mat. Vegetation, of course, has been seeded beforehand with any of these materials and it comes through the mat to provide for permanent stabilization.

We have found that fiberglass roving is the most cost effective material available and is our main ditch liner statewide. The ultimate in ditchline erosion control is the use of a rock surface which may be rip rap or stone for erosion control. This allows for high velocities and large volumes of water, as it has the ability to slow down velocities and do an excellent job of protecting the underlying soil surfaces.

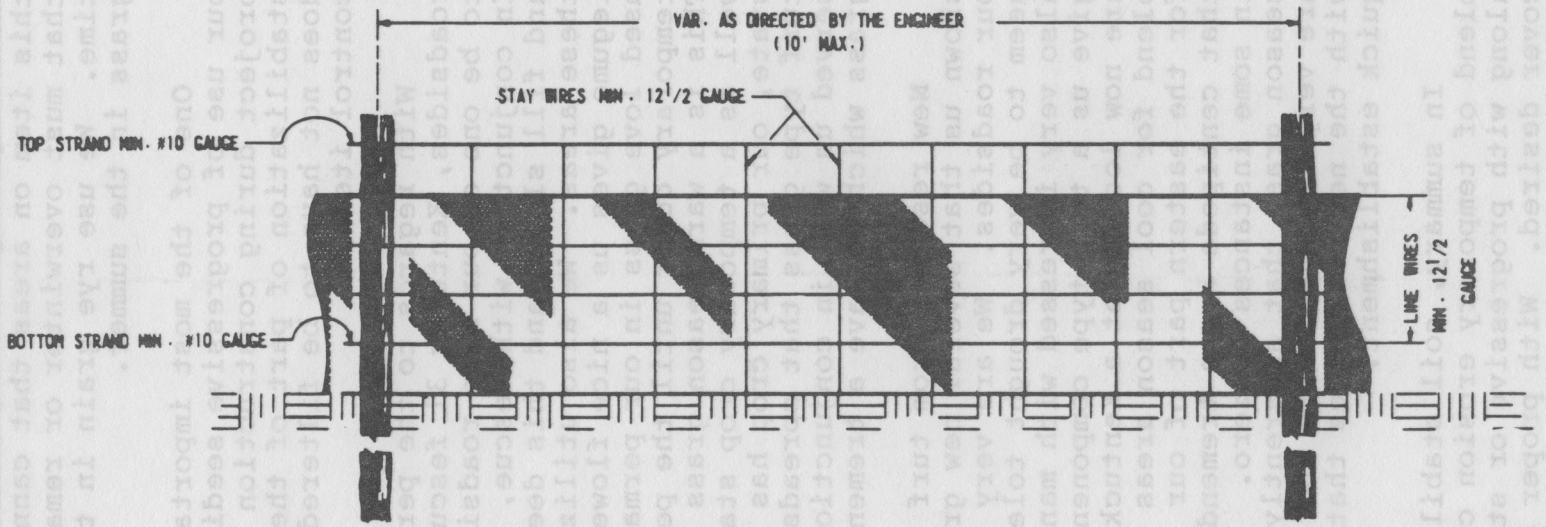
Temporary seeding has been very beneficial to us as we utilize this item on areas that cannot be completed to line and grade and that must overwinter or remain in that condition for some period of time. We use rye grain in the winter for this purpose and sudan grass in the summer.

One of the most important items in permanent erosion control is our use of progressive seeding. This is the process of seeding a project during construction in stages to provide for permanent stabilization of part of the project so that the total drainage area does not have to be filtered and managed by your temporary erosion control items.

With regards to the permanent grasses that we use along our roadsides, Kentucky 31 fescue has been used for years and continues to be one of our main roadside covers in the piedmont and mountains. In conjunction with fescue, we use sericea lespedeza on our large cut and fill slopes and this deep rooted legume has done very well in these areas. We also utilize crown vetch in some locations and this legume gives us a nice flower during part of the season. We have used love grass in our permanent mixture on slopes to function as a temporary cover until the permanent legumes can get established. This is a warm season grass that is very quick to establish and does well as a temporary crop statewide. In the eastern part of the state, our primary crop has been pensacola bahiagrass, a warm season turf type grass that spreads by rhizomes. This particular grass has served us well in conjunction, in many instances, with common bermuda grass which we have a tremendous amount of along our older roadsides.

New research from turf specialists at N.C. State University has shown us that several new grasses can be of much benefit to us along our roadsides. We are very impressed with the new hard fescues that seem to be very drought tolerant, low growing, and dense. We are also very impressed with many of the new bluegrasses which should give us a turf type component to our cool season grass mixture. We are now looking at a Kentucky 31 fescue, hard fescue, and bluegrass blend for cool season areas of the state. The other new component for the eastern part of our state has been rather dramatic. We feel that centipede has a tremendous potential to reduce mowing, possibly in some instances to zero. This, of course, is a turf type warm season grass that apparently has an allelopathic effect on weeds. We are very impressed with the potential for centipede, particularly with the new herbicides that might allow for its early release and quick establishment.

In summary, soil stabilization and erosion control must be a blend of temporary erosion control items during the project life along with progressive or stage seeding into the permanent vegetation cover desired. With proper management, there is no reason that off-site sedimentation damage has to occur from a project or that continuing erosion control problems have to exist in the future.



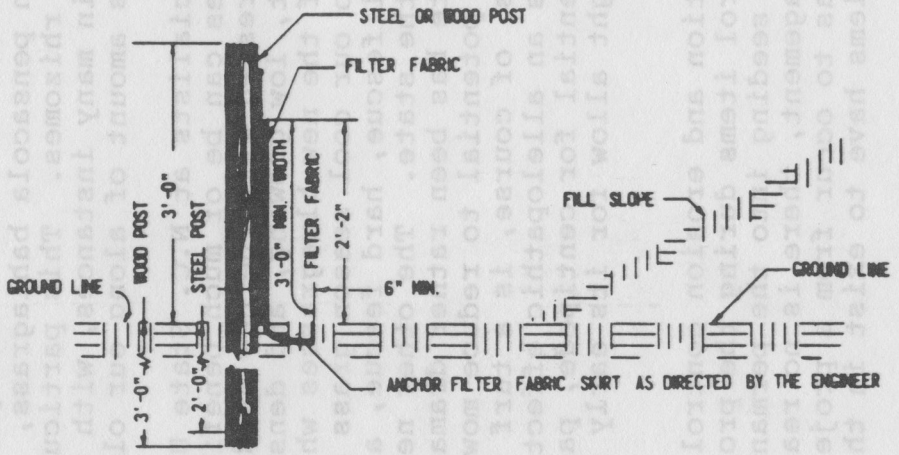
GENERAL NOTES:

WIRE SHALL BE A MINIMUM OF 32 INCHES IN WIDTH AND SHALL HAVE A MINIMUM OF 6 LINE WIRES WITH 12" STAY SPACING.

FILTER FABRIC SHALL BE A MINIMUM OF 36" IN WIDTH AND SHALL BE FASTENED ADEQUATELY TO THE WIRE AS DIRECTED BY THE ENGINEER.

STEEL POSTS SHALL BE 5'-0" IN HEIGHT AND BE OF THE SELF-FASTENER ANGLE STEEL TYPE.

WOOD POST SHALL BE A MINIMUM OF 6' IN HEIGHT AND 3" OR MORE IN DIAMETER. WIRE FABRIC SHALL BE FASTENED TO WOODEN POST WITH NOT LESS THAN #9 WIRE STAPLES 1 1/2 INCHES LONG.

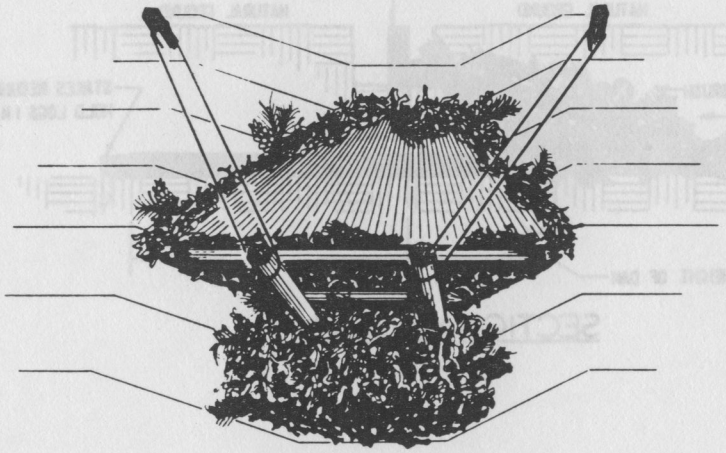


REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD TEMPORARY SILT FENCE

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
893.01	



PERSPECTIVE

GENERAL NOTES

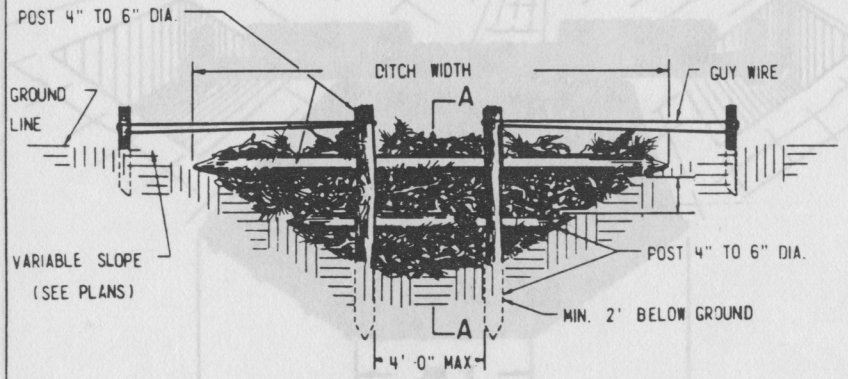
SILT CHECK DAM TO BE USED WHERE BASE OF DITCH IS 4'-0" OR LESS.

USE MATERIALS FROM CLEARING OPERATION WHEN AVAILABLE.

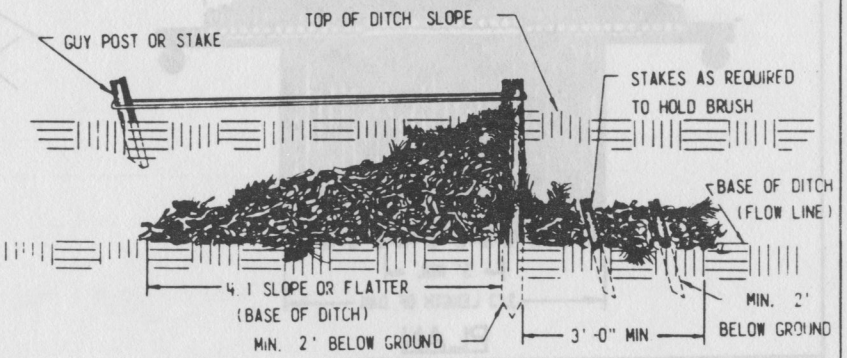
WHERE LOGS ARE NOT AVAILABLE WOVEN WIRE FENCE MAY BE USED TO RETAIN WOODS LITTER FOR BRANCH FILTER.

IF WOVEN WIRE FENCE IS USED. THE WIRE SHALL BE ANCHORED SECURELY AND TO THE SATISFACTION OF THE ENGINEER PRIOR TO PLACING THE LITTER AND FOLIAGE FILTER MATERIALS.

POST TO BE GUYED TO STAKES OR OTHER POST AHEAD OF BARRIER WITH NO. 7 GAGE GUY WIRE.



FRONT ELEVATION



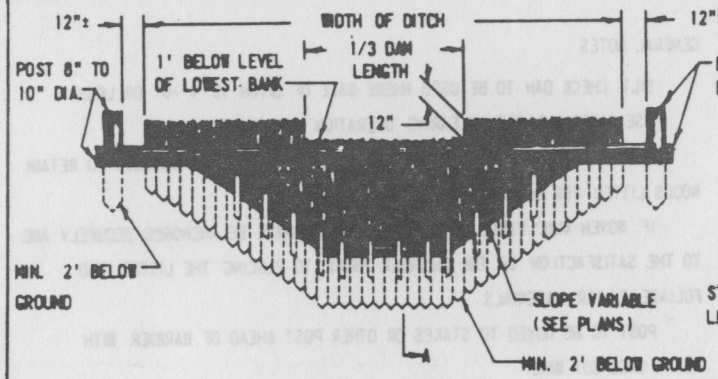
SECTION A-A

REVISIONS		
NO.	DATE	DESCRIPTION

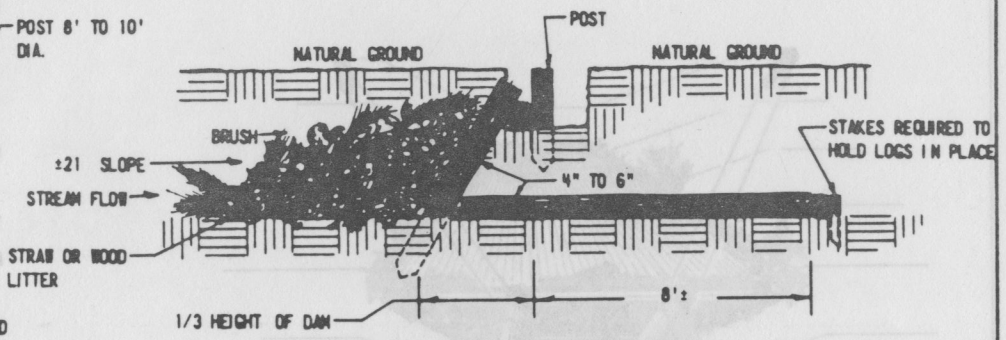
STANDARD SILT CHECK DAM TYPE B

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

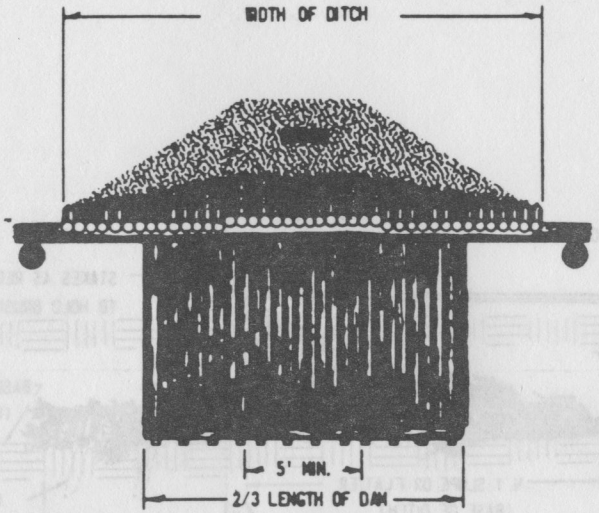
STD. NO.	REV.
892.02	



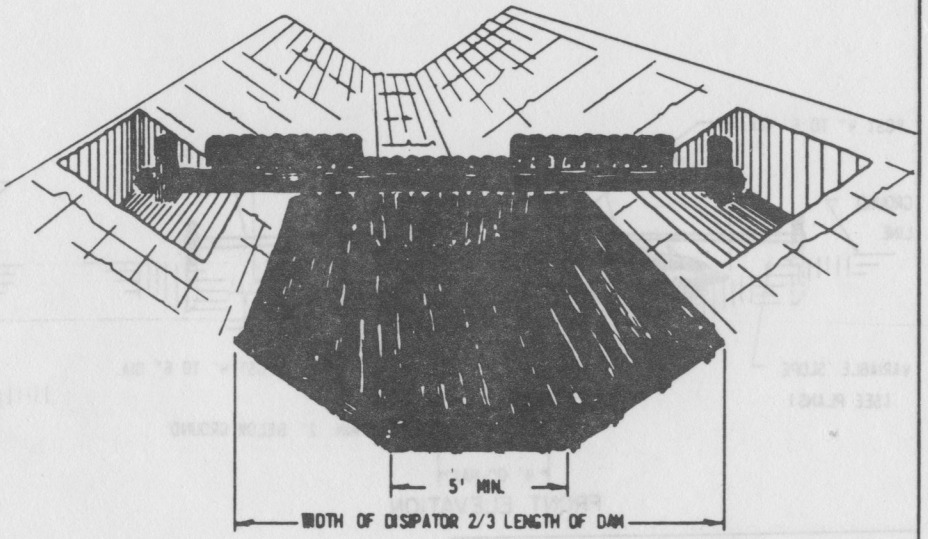
FRONT ELEVATION



SECTIONAL VIEW



PLAN



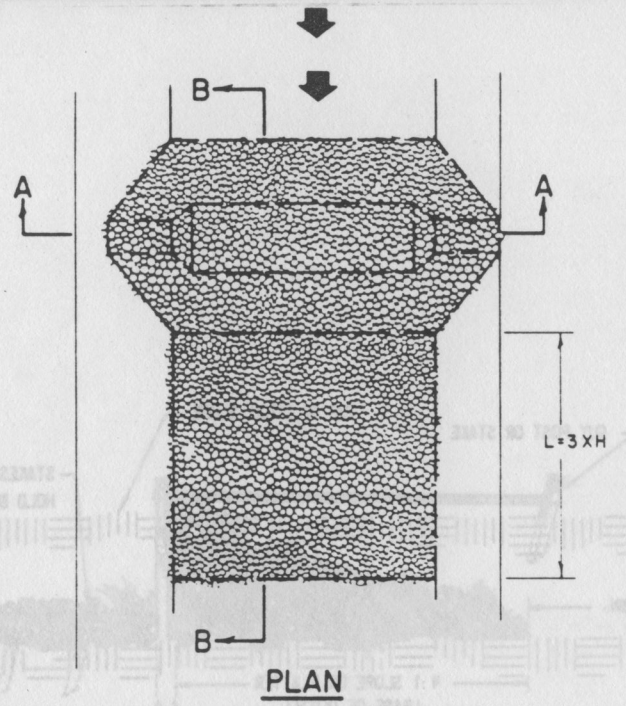
PERSPECTIVE

REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD SILT CHECK DAM TYPE A

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
892.01	



PLAN

NOTE

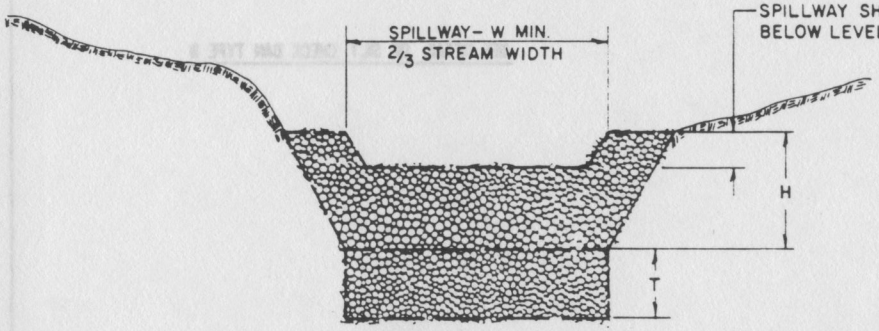
ROCK SHALL BE CLASS I RIP RAP OR STONE FOR EROSION CONTROL (CLASS "B").

H= DISTANCE FROM BOTTOM OF DITCH TO LOWEST SIDE OF DITCH BANK.

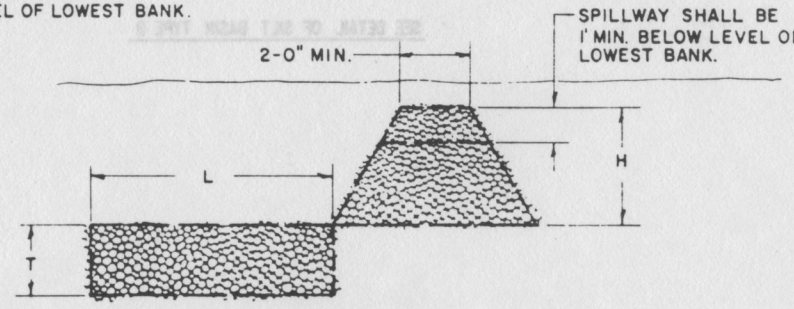
T= 18" FOR CLASS I RIP RAP

T= 12" MIN. STONE FOR EROSION CONTROL (CLASS "B").

TO BE PAID FOR AT THE CONTRACT UNIT PRICE PER EACH "ROCK SILT CHECK DAM".



SECTION-AA



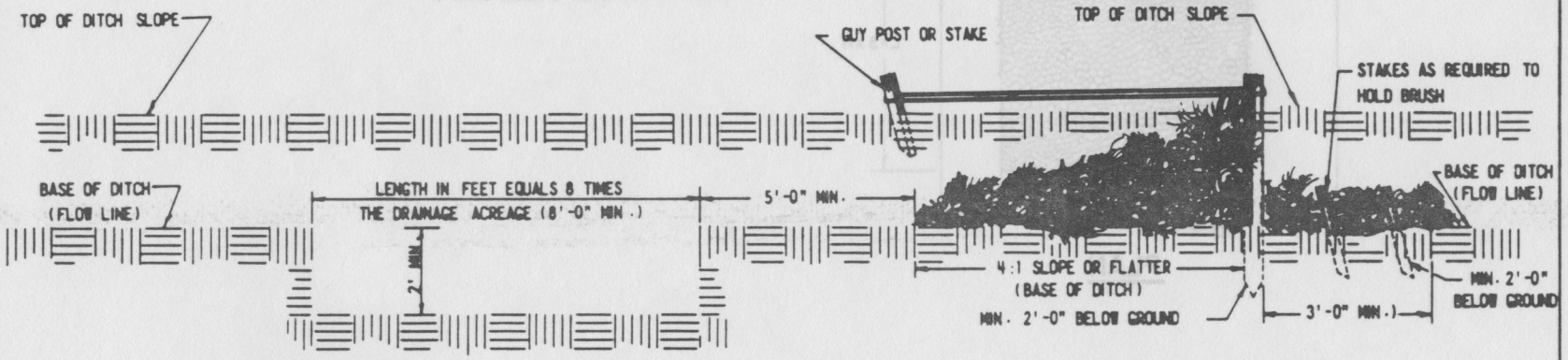
SECTION-BB

REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD GUIDE FOR TEMPORARY ROCK SILT CHECK DAM

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
892.04	

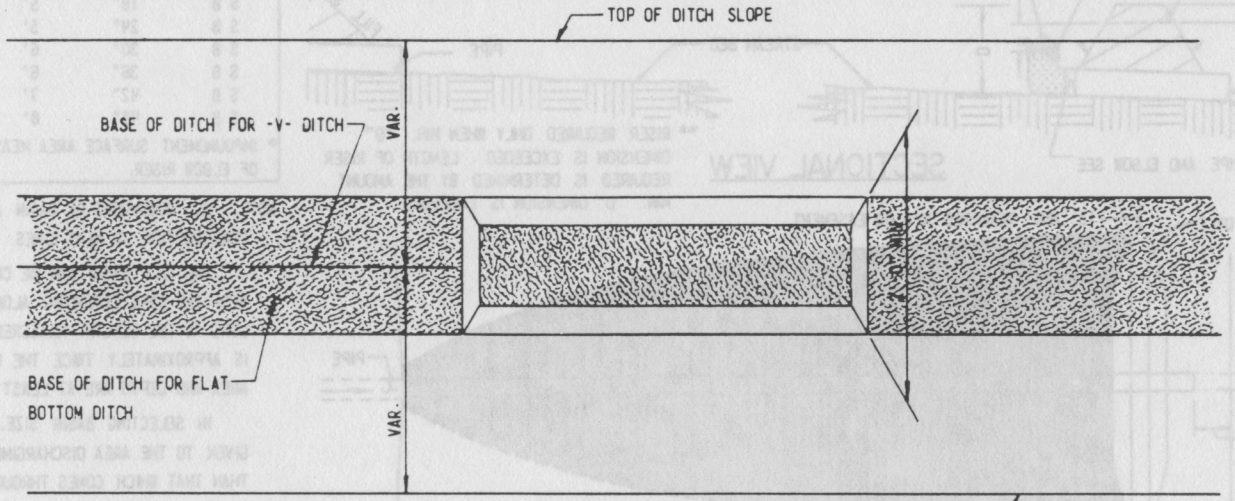


REVISIONS		
NO.	DATE	DESCRIPTION

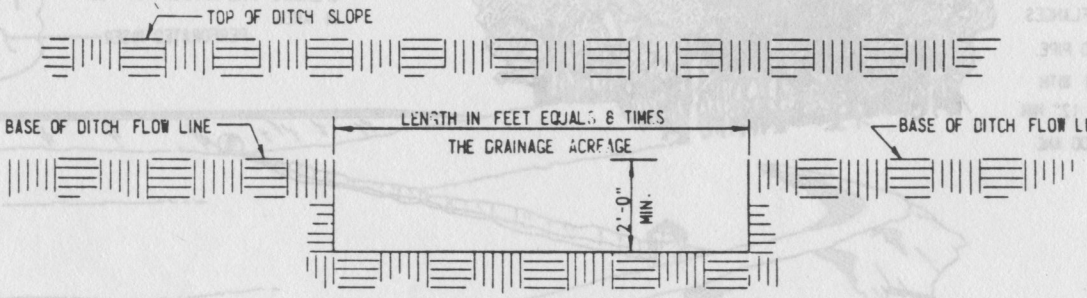
STANDARD SHOWING COMBINATION OF SILT CHECK DAM TYPE B AND SILT BASIN TYPE B

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
862.03	



PLAN



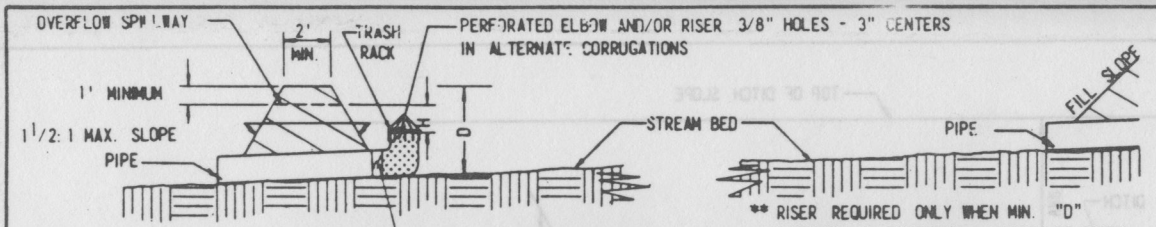
ELEVATION

REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD SILT BASIN TYPE B

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
245.02	



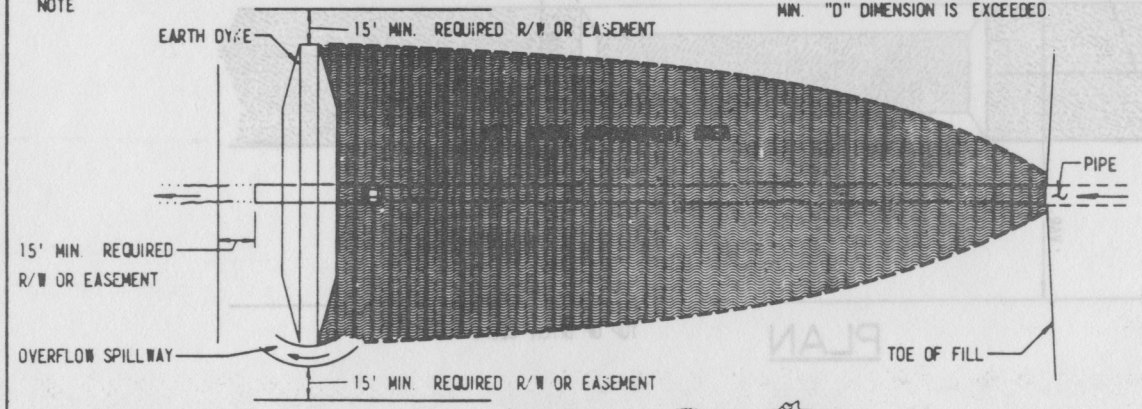
FOR FABRICATION OF PIPE AND ELBOW SEE NOTE

SECTIONAL VIEW

** RISER REQUIRED ONLY WHEN MIN. "D" DIMENSION IS EXCEEDED. LENGTH OF RISER REQUIRED IS DETERMINED BY THE AMOUNT MIN. "D" DIMENSION IS EXCEEDED.

SPILLWAY	PIPE	**D (MIN.)	H (MIN.)	AREA (SQ. FT.)*
S B	15"	4'	1'	310
S B	18"	5'	1'	550
S B	24"	5'	1'	1100
S B	30"	6'	1.5'	1850
S B	36"	6'	1.5'	2800
S B	42"	7'	2.0'	4200
S B	48"	8'	2.0'	6200

* IMPOUNDMENT SURFACE AREA MEASURED AT ELEVATION OF TOP OF ELBOW RISER.



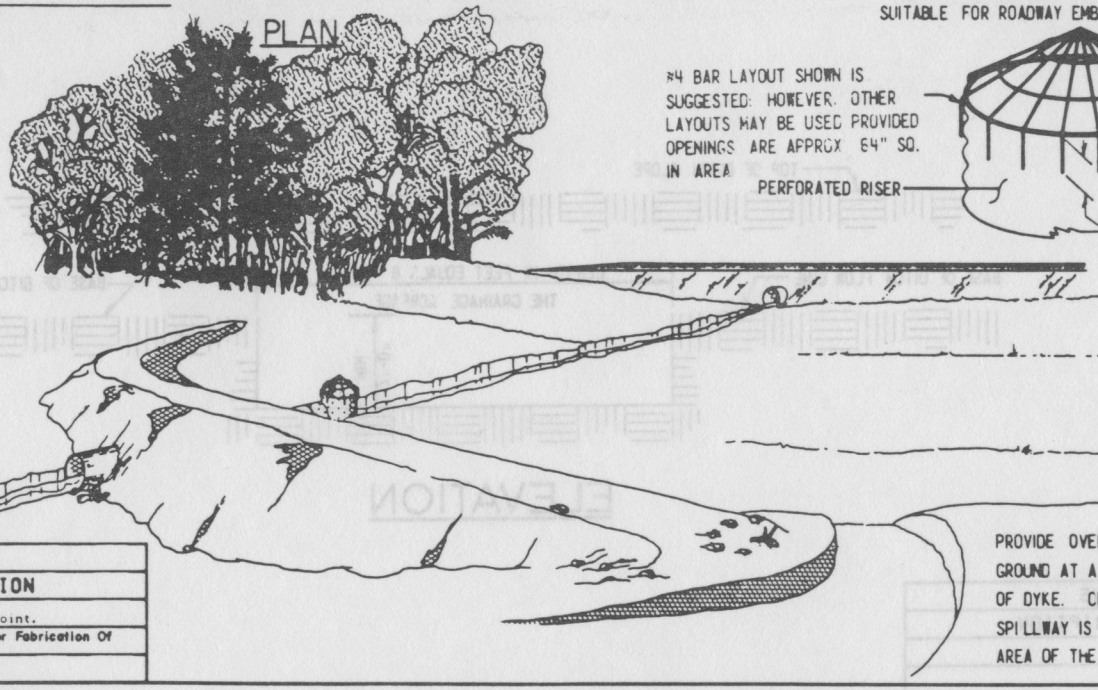
NOTE: ALL DIMENSIONS OF BASIN AND DYKE WILL NOT REQUIRE CONSTRUCTION TO NEAT LINES.

THE SILT BASIN MAY BE CONSTRUCTED IN ANY SHAPE WITH THE DYKE EXTENDING ALONG ONE OR MORE SIDES AS LONG AS THE LENGTH, MEASURED IN THE DIRECTION OF FLOW IS APPROXIMATELY TWICE THE WIDTH AND THE IMPOUNDMENT AREA AND DEPTH ARE AT LEAST AS LARGE AS INDICATED.

IN SELECTING BASIN SIZE, CONSIDERATION MUST BE GIVEN TO THE AREA DISCHARGING INTO THE BASIN OTHER THAN THAT WHICH COMES THROUGH THE PIPE UNDER THE ROADWAY. THIS WILL AT TIMES NECESSITATE A LARGER BASIN AND OUTLET PIPE SELECTION.

THE DYKE SHALL BE CONSTRUCTED OF MATERIAL SUITABLE FOR ROADWAY EMBANKMENT.

PLAN



OPTIONS FOR FABRICATION OF PIPE AND ELBOW (INCLUDING RISER WHEN REQUIRED) ARE AS FOLLOWS:

1. FABRICATED AS ONE UNIT.
2. FLANGED WITH 1/4" FLANGES WELDED TO ELBOW AND PIPE.
3. ANNULAR ENDS JOINED WITH ANNULAR CORRUGATED 12" MIN. WIDTH BANDS WITH ROD AND LOG CONNECTORS.

#4 BAR LAYOUT SHOWN IS SUGGESTED; HOWEVER, OTHER LAYOUTS MAY BE USED PROVIDED OPENINGS ARE APPROX 64" SQ. IN AREA.

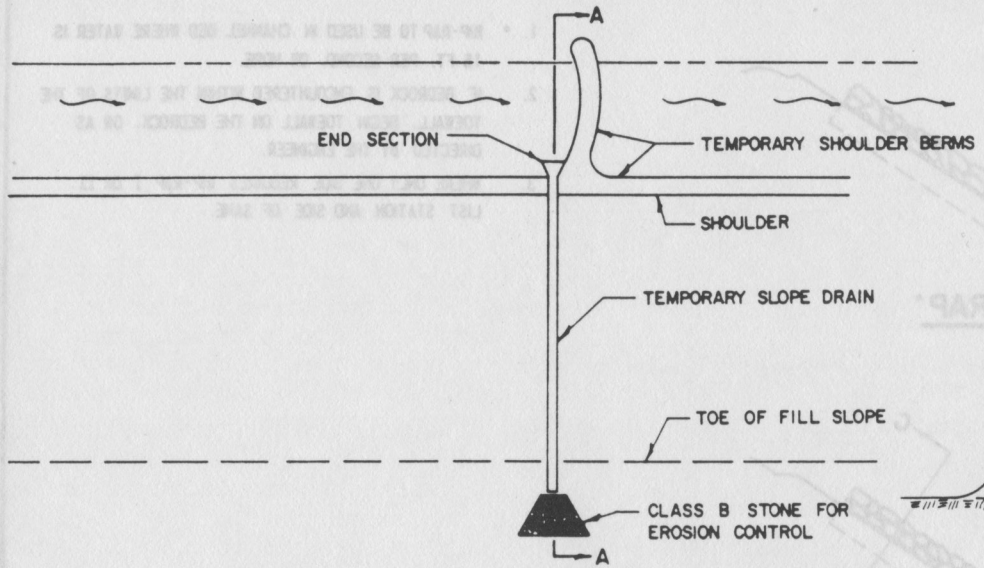
PROVIDE OVERFLOW SPILLWAY IN NATURAL GROUND AT A MINIMUM OF 1' BELOW TOP OF DYKE. CROSS SECTIONAL AREA OF SPILLWAY IS EQUAL TO 1.5 TIMES THE AREA OF THE OUTLET PIPE.

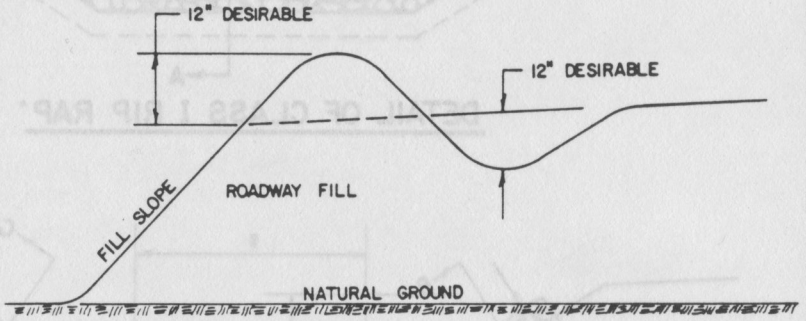
REVISIONS		
NO.	DATE	DESCRIPTION
A	10-10-78	Changed Note on Elbow joint.
B	10-26-82	Added Notes For Options For Fabrication Of Pipe And Elbow

STANDARD SILT BASIN TYPE A

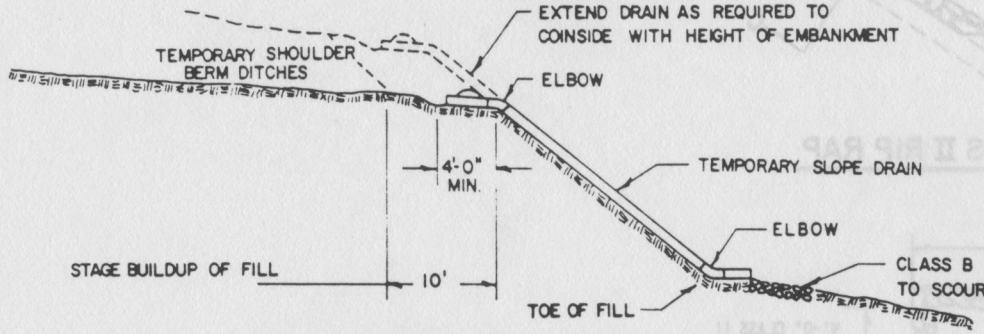
STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
245.01	B





TEMPORARY SHOULDER BERM DITCH



SECTION-AA

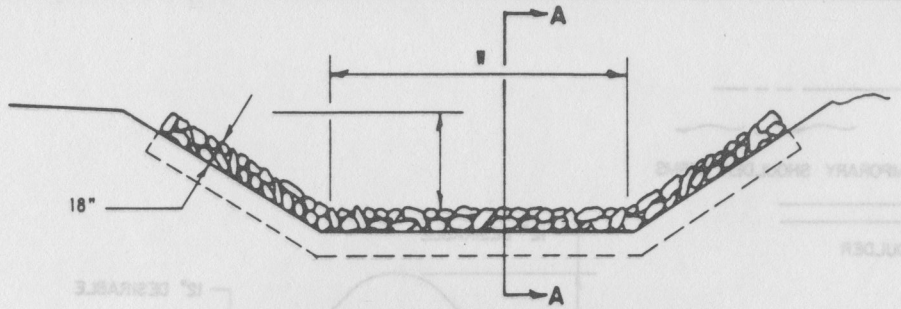
TEMPORARY SLOPE DRAIN

REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD GUIDE FOR TEMPORARY BERMS AND SLOPE DRAIN

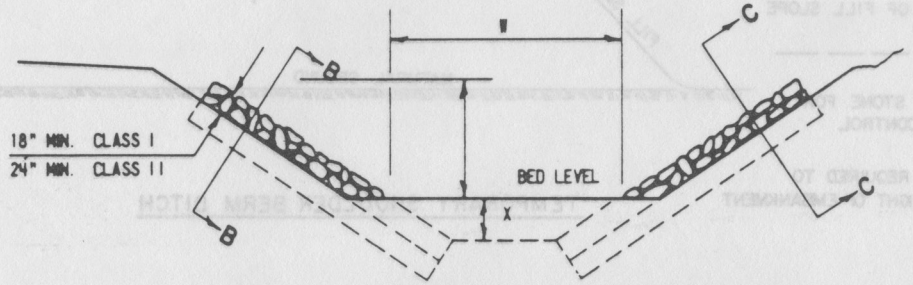
STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
890.05	

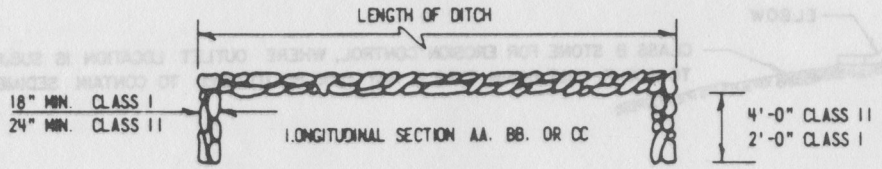


DETAIL OF CLASS I RIP RAP*

1. * RIP-RAP TO BE USED IN CHANNEL BED WHERE WATER IS 15 FT. PER SECOND. OR MORE.
2. IF BEDROCK IS ENCOUNTERED WITHIN THE LIMITS OF THE TOEWALL. BEGIN TOEWALL ON THE BEDROCK. OR AS DIRECTED BY THE ENGINEER.
3. WHERE ONLY ONE SIDE REQUIRES RIP-RAP I OR II. LIST STATION AND SIDE OF SAME.



DETAIL OF CLASS I OR CLASS II RIP RAP



LONGITUDINAL SECTION AA, BB, OR CC

CLASS I	
* W	X
0'-5"	BED LEVEL
6'-10'	12"
11'-20'	18"

*FOR "V" DITCH W IS 0'.

CLASS II	
W	X
ALL	36"

REVISIONS		
NO.	DATE	DESCRIPTION

STANDARD RIP RAP IN DITCHES

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS
RALEIGH, N. C.

STD. NO.	REV.
868.01	

TURFGRASS GROWTH SUPPRESSION

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Mowing continues to be a time consuming and expensive cultural practice. Many sites are hard to reach and often dangerous for the operator or nearby personnel. Plant growth regulators are often compared to mechanical mowing. It is well known that turfgrass growth inhibition is usually accompanied by some degree of temporary leaf discoloration which is enhanced if the turf is under stress such as wilt or traffic. However, it is not often remembered that improper mowing can result in scalping, unsightly clipping accumulation, stand reduction and root loss. Regulator applications and mechanical mowing require planning, equipment maintenance and adjustment, and alert operators. Growth regulator applications are perhaps more difficult than many other pesticide treatments since application rates are very low and skips very obvious.

Commercially available turfgrass growth regulators include amidochlor (Limit), chloroflurenol (Maintain CF125), chlorsulfuron (Telar), EPTC (ShortStop), glyphosate (Roundup), maleic hydrazide (MH), mefluidide (Embark), paclubutrazol (TGR), and sulfometuron methyl (Oust) (Table 1). Maleic hydrazide is foliarly absorb and typically applied at 2 to 4 lb ai/A. It is an excellent seedhead suppressant of many grasses (tall fescue, bluegrass, ryegrass, bahiagrass, bermudagrass, etc.). Mefluidide is foliarly absorbed and applied at 0.125 to 0.5 lb ai/A (0.5 to 2 pints of formulation per acre) for seedhead inhibition. Seedhead suppression of tall fescue by mefluidide has been best at 0.38 to 0.5 lb ai/A (1.5 to 2 pints of formulation per acre) along with the use of a surfactant at 0.5% v/v. Combinations of mefluidide and chlorsulfuron at 0.125 lb + 0.125 oz will provide excellent seedhead suppression of tall fescue. Unlike maleic hydrazide and mefluidide, amidochlor is primarily root absorbed and is applied at 2.5 lb ai/A. This regulator is more active as a vegetative growth suppressant than maleic hydrazide and mefluidide and is somewhat less phytotoxic.

Tall fescue seedhead suppression under roadside conditions has been successfully attained following spring applications of amidochlor at 2.5 lb ai/A, glyphosate at 0.25 lb ai/A, maleic hydrazide at 2 to 4 lb ai/A), mefluidide plus surfactant at 0.38 to 0.5 lb ai/A, and mefluidide plus chlorsulfuron at 0.125 lb and 0.125 oz ai/A. EPTC at 6 to 8 lb ai/A, DPXT6376 at 0.25 to 0.5 oz ai/A and ACP1900 at 8 to 32 grams ai/A also had activity as seedhead suppressants of tall fescue.

Studies at NCSU by this author and Drs. W. B. Gilbert and W. M. Lewis have demonstrated that 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 are more phytotoxic to tall fescue than spring treatments. While spring seedhead suppression following fall applications does occur, results have not exceeded 70% inhibition.

During 1984, Escort (metsulfuron methyl) applied on 30 March was nearly twice as effective in suppressing tall fescue seedheads as a 12 April application. Treatment with Shortstop (EPTC) gave good seedhead control of tall fescue when applied on 12 April 1985, but resulted in unacceptable control when applied two weeks earlier on 27 March, 1985. However, the experimental regulator ACP1900, was more effective when applied on 27 March 1985 than when treatments were applied on 12 April.

The previous examples demonstrate that growth regulator activity varies with the time of year, and most likely with the stage of development of the plant. Correlations between seedhead length and growth regulator seedhead suppression activity were found to be highly significant. Inflorescence length was found to be inversely related to the seedhead suppression activity of maleic hydrazide, amdiochlor and mefluidide. Increased seedhead size at the time of application is accompanied by reduced likelyhood that growth regulator treatment will suppress inflorescence development.

Excellent suppression of tall fescue seedheads was obtained using maleic hydrazide at 4 lb ai/A applied between the initiation of inflorescence development (late March) and the point of rapid elongation of the seedhead in late April and early May. Evaluations from 1982 through 1985 have shown that the rapid elongation phase of tall fescue seedhead development begins about two weeks prior to the emergence of the seedhead. More recently, the relationship between seedhead length, seedhead suppression and growing degree days (GDD) is being examined as a possible practical approach to defining the activity periods of plant growth regulators. Thus far, a GDD defined as the degree days accumulated beginning March 1 using a base temperature of 40 °F has been significantly correlated with the suppression activity of maleic hydrazide, amidochlor and mefluidide. Tall fescue seedhead suppression during 1982 through 1985 exceeded 90% when maleic hydrazide application were made after a mean GDD accumulation of 211, but prior to a mean GDD of 585 (Table 2).

Bahiagrass seedhead suppression trials have continued to be conducted at Pope Air Force Base in Fayetteville, NC. May applications of ACP1900 at 4.5 to 32 grams ai/A, gylphosate at 0.19 or 0.25 lb ai/A, maleic hydrazide at 3 to 4 lb ai/A, and sulfometuron methyl at 0.5 oz ai/A effectively suppressed bahiagrass seedheads through early August. Unlike tall fescue, bahiagrass produces seedhead thorughout the summer.

Table 1. Selected characteristics of turfgrass growth regulators.

COMMON NAME	TRADE NAME	FORMULATION	UPTAKE SITE	APPLIC. RATE	PGR ACTIVITY	TURF'	ORAL LD50
Amidochlor	Limit	4#/G F	Root	2.5 lb	Vegetative Seedhead	KB,FF,R TF	3100 mg/kg
Chlorsulfuron	Telar	75DF	R/F	0.125 w/mef	Vegetative Seedhead	TF	5445 mg/kg
EPTC	Short-Stop	10G	R/F	4-8 lb	Vegetative Seedhead	TF	>5000 mg/kg
Flurprimidol	Cutless	50W	Root (F)	0.5-3 lb	Vegetative	Most	>5000 mg/kg
Glyphosate	Roundup	4#EC	Foliar	0.25-0.5 lb	Vegetative Seedhead	BH,TF	5400 mg/kg
Maleic hydrazide	Slo-Gro Retard	1.5 #/G L	Foliar	2-4 lb	Vegetative Seedhead	KB,FF,R BM,BH,TF	---
Mefluidide	Embark	2#/G L	Foliar	1/8-0.5 lb	Vegetative Seedhead	KB,FF,R BM,TF	>4000 mg/kg
Paclobutrazol	Parlay	50W	Root	0.5 - 2 lb	Vegetative	Most	---
Sulfometuron methyl	Oust	75DF	R/F	0.25-4 oz	Vegetative Seedhead	BH	>5000 mg/kg

' KB= Kentucky bluegrass, FF= fine fescue, R= ryegrasses, BM+ bermudagrass, BH= bahiagrass, and TF= tall fescue. Application rates in ai/A.

Table 2. Growing degree days accumulated during 1982 through 1985 for dates of MH application which resulted in at least 90% tall fescue seedhead suppression.

Year	Minimum	Maximum
	- - - - - - GDD' - - - - - -	
1982	48	480
1983	338	677
1984	163	461
1985	294	721
Mean	211	585

' GDD = Growing degree days accumulated beginning March 1 of each year using a base temperature of 40 °F.

Insect Control in Sod and Athletic Fields

Dr. Rick L. Brandenburg
NCSU

Athletic fields and sod can be seriously affected by several insect pests. These insects result in additional stress that retards growth and vigor of the grass and promotes early death of the plant and thinning of the turf. Although control techniques vary with the individual pests, scouting the turf or sod area to detect the insects before damage occurs is essential.

Soil Insects

There are two types of insects in turf: those that feed on the grass above the soil line and those that feed below the ground. Perhaps the most important insects feeding on the roots are white grubs. These are the larvae of various scarab beetles including the Japanese beetle. All white grubs of economic importance have a one-year life cycle. Insecticides must be applied from late March to early May and August through September to obtain best results. These insecticides must also be watered in immediately after application. Control may take as long as two or three weeks.

The green June beetle is a white grub with slightly different habits. This insect feeds on decaying plant material rather than the roots and damages by extensive tunneling and loosening of the soil. Green June beetles exhibit the unusual habit of crawling on their backs across the soil at night. Control with insecticides requires the chemical to be applied to the soil and not watered in.

Mole crickets appear to be increasing in importance in North Carolina. Typically a pest in sandy soils, these insects can be very destructive to golf greens and newly seeded grass. The young nymphs are most destructive during August and September. Baits are very effective for control if properly applied. The infested area should be watered prior to treatment. This will ensure that the mole crickets will be in the root zone feeding. Baits should be applied only if temperatures at night are exptected to be 60°F or warmer. Do not irrigate over the baits for at least 24 hours. Following these guidelines will enhance the level of control provided by these baits.

Surface Feeding Insects

Several species of insects feed directly on the grass blades either by chewing or sucking plant juices. Cutworms and armyworms are typical of these. These insects feed at night and hide in the mulch and soil during the day. They often escape detection until extensive damage has occurred. In general, one caterpillar per square foot can cause extensive damage, and areas such as golf greens are even more susceptible. Treatments should be applied to the grass and then the grass not mowed for 2 or 3 days. This provides ample opportunity for the insect to be exposed to the insecticide.

Sod webworm moths are frequently seen flying at dusk over turf from May to October. The larvae live in tunnels but come to the surface to feed at night. Insecticides should be applied to the grass and not watered in. Treating late in the afternoon and delaying irrigation or mowing for 2 or 3

days will enhance the level of control. These same control techniques apply for sporadic insect pests such as leafhoppers and spittlebugs.

Ants and wasps can be nuisance pests in home lawns. Maintaining good, thick stands of grass helps to reduce infestations of these insects.

Early detection of turf insect pests is essential. However, treatments should not be based upon damage or symptoms alone. Such a practice can lead to unnecessary and ineffective treatments. Symptoms or damage can be misidentified and/or the insects causing the damage may no longer be in the area. Be sure damaging levels of the insect are still present before an insecticide is applied.

INSTALLATION AND CARE OF SOD

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Diane Rose, Graduate Student, Crop Science
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Sodding offers fast establishment, quicker use of high trafficked areas such as athletic fields and reduced chances of failure and erosion compared to the traditional method of seeding. Sod can be done when seeding is not possible thus extending the planting season. High cost and limited availability of plant material are the major disadvantages.

Purchase planting material free of objectionable broadleaf and grassy weeds. Planting certified sod is a good way of insuring that the material being purchased is true-to-type and free of objectionable weeds and crop species. Planting material containing hard-to-control perennial grassy weeds can reduce turf quality for years to come.

Plant only improved, adapted grasses. Proper grass selection in combination with correct establishment procedures will result in a durable turf with minimal maintenance and little need for pesticides.

WHEN TO SOD

Cool season grass sod is best installed in the fall, but can be installed any time the ground is not frozen and the means to irrigate are available. Warm season grasses are best sodded in the spring or early summer after soil temperatures reach 50 F. Preliminary results from research conducted at North Carolina State University suggest that bermudagrass can be successfully installed during the winter months provided the sod is not allowed to desiccate. Research is continuing to verify these intial findings.

INSTALLATION

Installation begins with proper site preparation. Remove debris and perennial grassy weeds using a non-selective herbicide such as glyphosate. Remove topsoil, if present, shape the underlying soil to the proper contour, grade and redistribute the topsoil evenly over the surface. Water or roll the area and fill in areas that settle to avoid standing water. If topsoil or amendments 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 to a minimum of 4 inches using a rototiller or disk. Insure that the sample being submitted for analysis is 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 soil samples to your county Extension office for testing by the Agronomic Division of 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 approach the size of pea gravel. Water thoroughly, roll or cultipack to allow settling and firm the soil. Hand rake to break up the crusty surface prior to sodding. The finished grade should be about 3/4 to 1 inch 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 ensure 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 installed no later than 24 hours after delivery. Place sod 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 the soil underneath is wet. Sod should be kept continually moist by daily watering until 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 icnreasing 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 turf. A high phosphorus (starter fertilizer) applied three to four weeks after intallation ;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 transplanted 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 improtant to maintaining a high quality turf.

TURFGRASS PHYSIOLOGY AND MANAGEMENT RESEARCH UPDATE

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North Carolina State University
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Growth retardant studies have continued on tall fescue, bahiagrass and bermudagrass under both low and moderate maintenance conditions, while new trials were initiated on perennial ryegrass and Kentucky bluegrass. 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. Additional information concerning the results of these trials can be found in another article in these proceedings.

The performance and survival of warm season turfgrasses through the winter months continues to be investigated. Tifgreen and Tifway bermudagrass have been being evaluated for ways to enhance the survival of sod transplanted during the off-season while the bermudagrass is dormant. Treatments included potassium fertility, cutting height, plant hormone applications, antitranspirant coatings, overseeding and thickness of sod.

Syringing studies for 1986 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.

It is a pleasure to acknowledge the financial and material program support from the following:

BASF	**E.J. Smith**	**Monsanto**	**Smith Turf & Irr.**
CGA	**FHWA**	**NCDOT**	**Tin Whistles**
Carolina Sod	**Goltra**	**Northrup King**	**Turf Seed**
Ciba-Geigy,	**ISI**	**O.M. Scotts & Son**	**United Turf**
Cyanamid,	**Lesco**	**Porter Brothers**	
DuPont	**Lofts**	**Pickseed West**	

The excellent efforts of David Beard, Walter Davis, Mike Newnam, Les Privette, Darrell Sapp, Leon Warren, Diane Rose, Bill Rose and Derek Smith are sincerely appreciated. 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, Mr. Henry Fox, Mr. Lewis Clark and the personnel of the NCDOT Landscpe Unit.

TURF EXTENSION UPDATE

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PUBLICATIONS. The following publications have been released or will be available by June 1, 1986 at your county Agricultural Extension office.

1. "Overseeding Bermudagrass Turf" (AG-352) - A 16-page guide to winter overseeding of bermudagrass greens, tees, fairways, athletic fields and lawns.

2. "Diseases of Warm Season Grasses" (AG-360) - A 4-page publication which includes color photographs, an occurence chart and description of the symptoms of the major diseases that infect warm season grasses. Cultural tips that can help in preventing or reducing turf damage by the diseases is also listed. This publication can be used as a flyer by nursery, garden center, and lawn care personnel. Space is available for placing the name and address of the firm providing the service. Supplies are limited, however, additional copies will be printed if interested parties are willing to pay for the reprinting of the publication.

3. "Diseases of Cool Season Grasses" (AG-361) - A 4-page publication similar to the "Diseases of Warm Season Grasses" mentioned above. Supplies are also limited, however, additional copies will be printed if interested parties are willing to pay for the reprinting of the publication.

4. "Tall Fescue Lawn Maintenance Calendar" - Information concerning the management of tall fescue is presented in a calendar format and based on North Carolina Agricultural Extension Service recommendations. The single sheet publication is designed to be displayed for easy reference and discusses such topics as mowing, watering, fertilizing, aerification, power raking, overseeding and pest control.

5. "Centipedegrass Lawn Maintenance Calendar" - Information concerning the management of centipedegrass turf is presented in a calendar format and based on North Carolina Agricultural Extension Service recommendations. The single sheet publication is designed to be displayed for easy reference and discusses such topics as mowing, watering, fertilizing, aerification, power raking, renovation and pest control.

6. "Algae and Moss Control in Turf" (Turf Memo 20) - A single sheet that discusses the measures available regarding the prevention and control of algae and moss.

OTHER PROJECTS. Additional funding was received from the North Carolina Agricultural Foundation to complete the permanent self touring turfgrass management demonstration area located adjacent to the existing NCSU turfgrass research field plots. This facility provides an opportunity to clearly demonstrate the benefits of correct agronomic practices and incorporate various themes of management. A number of ornamental grasses have recently been planted for display purposes. The area will be periodically updated to reflect the latest research developments.

A grant was received to continue the monitoring of pest activity in four counties to include Guilford, Moore, New Hanover and Wake. Information, sent in by trained scouts, is recorded and advisory bulletins released on a weekly basis. Information is available to managers within each participating county via the Extension Teletip program.

The TCNC and N.C. Agricultural Service jointly sponsored a turfgrass demonstration area during the North Carolina State Fair. The area, made available by the Men's Garden Club of Wake County, allowed fair goers to view first hand most of the major lawn grasses and weeds grown in North Carolina.

A software program, developed at NCSU, is now available that can aid turf managers in the identification of turf and weedy grasses. The program is menu driven and includes three files: a) a main program (31K), b) a glossary file (14K) and c) a characteristic listing. The user may identify an unknown specimen, list the characteristics of a specific grass, run an example key, or check a word in the glossary.

Extension Entomology Update

Dr. R. L. Brandenburg, NCSU

Numerous Extension Entomology projects are currently underway relating to turf. Department Insect Notes on Sod Webworms (Note #8) and Insects of Commercial Turf and Their Control (Note #67) were updated and reprinted. A new Insect Note, White Grub Control (Note #68) was written and printed. Two additional publications are in preparation. One discusses ants and their control while the other concerns mole cricket management.

Insecticide evaluations were conducted for mole cricket and white grub control. Additional studies are necessary, but several new compounds look promising. Additional work on refining mole cricket control techniques is underway. Future studies will investigate the impact of various management techniques on ground pearls.

Development of two new educational tools is in progress. A slide series of major turf pests is being assembled. These slides will focus on identifi-cation of pests and damage. A second educational tool is the development of a video tape on turf insects. This tape will illustrate how to examine turf for insect pests and control application techniques.

TURF DISEASE UPDATE

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Fungicides were evaluated for the control of dollar spot on bentgrass and nematicides were evaluated for the control of sting and stubby-root nematodes on common bermudagrass in 1985. Several experimental and registered fungicides were applied to a bentgrass plot at the turf research plots in Raleigh. Dollar spot is a problem annually on this bentgrass plot which is maintained similar to a golf green. Dollar spot symptoms were present at the time of the first fungicide application in May. All fungicides were applied on May 14 and again on June 4 using a CO_2 powered backpack sprayer. Treatments were replicated four times in 5 ft X 5 ft plots.

All fungicides except of SN86364 and NC28410 gave good to excellent disease control 2 and 4 weeks after treatment. Disease became severe in all treatments except RH 3866 about 7 weeks after the last treatment. This severe test of fungicides over this long period of time was used to evaluate the long term control from these chemicals (Table 1).

Two registered nematicides and one experimental nematicide were evaluated for sting and stubby root nematode control on a golf course fairway at Pinehurst. Sting and stubby root nematodes were present at the time of treatment in high and low numbers, respectively. The nematicides were applied on June 24. All nematicides were applied with a 1.5 ft wide Scotts spreader with the exception of CGA12223 1E which was sprayed with a CO_2 backpack sprayer. Water was applied at the rate of one-half inch immediately after application of the nematicides.

All nematicides significantly reduced the number of the sting nematode initially. However, after 3 months, Nemacur at the full and one-half rates had significantly lower numbers of sting nematodes. The stubby-root nematode was reduced significantly after one month by Mocap at the full and one-half rate. Nemacur was the best nematicide for sting nematode control over a longer period of time (Table 2). Mocap will be evaluated again for the control of stubby-root nematode since this nematode has been difficult to control in previous tests.

Table 1. Dollar spot control on bentgrass.

Treatment and Rate/1000 sq ft	% Area with Disease				
	24 May	4 Jun	18 Jun	2 Jul	22 Jul
Control	8.5	13.8	33.8	45.0	65.0
Vorlan 50WP 1.0 oz	2.8	2.8	1.3	8.8	25.0
MF745 50WP 1.5 oz	2.5	1.3	.8	4.0	16.3
MF690 50WP 1.5 oz	1.8	2.5	2.3	11.3	25.0
MF690 50WP 2.5 oz	2.0	1.3	.8	8.5	28.8
RH3866 40WP .5 oz	.8	.5	.3	.8	3.3
RH3866 40WP 1.0 oz	1.0	.3	0.0	.3	1.0
SN86364 50WP 1.0 oz	10.0	14.0	18.8	42.5	62.5
SN86364 50WP 2.0 oz	10.3	21.3	41.3	51.3	51.3
NC28410 40SC 2.0 oz	13.8	22.5	37.3	46.3	50.0
NC28410 40SC 4.0 oz	10.0	18.3	36.3	50.0	47.5
XE779 25WP .5 oz	2.8	4.0	2.5	15.0	32.5
XE779 25WP 1.0 oz	1.8	1.0	0.0	3.0	17.5
Tersan 1991 50WP 1.0 oz	2.8	.8	1.3	3.8	20.0
F-4921 50WP 1.0 oz***	3.3	5.3	12.5	31.3	50.0
F-4921 50WP 2.0 oz	1.3	2.5	9.5	22.5	35.0
HWG1608 125EW 1.0 oz	.8	.5	.3	1.5	10.0
Bayleton 25WP 1.0 oz	2.0	3.0	1.0	3.5	17.5
MSD (P = 0.05)**	4.4	7.8	8.0	13.9	17.6

**Treatments were analyzed using Waller Duncan
***One application

Table 2. Nematode control on common bermudagrass.

Treatment and Rate/1000 sq ft*	Nematodes/500 cc soil					
	Sting			Stubby root		
	24 Jun	22 Jul	28 Aug	24 Jun	22 Jul	28 Aug
Control	191.3	252.3	220.0	61.5	60.8	71.5
Nemacur 10G 4 lb	230.0	47.5	27.8	49.8	17.5	27.5
Nemacur 10G 2 lb	263.5	57.5	30.3	50.3	20.0	57.8
Mocap 10G 5 lb	277.8	80.0	112.8	61.3	0.0	22.0
Mocap 10G 2.5 lb	326.5	172.5	222.8	50.3	12.5	33.0
CGA12223 1G 4.6 lb	278.0	142.5	104.5	63.3	52.5	68.8
CGA12223 1E 2.6 oz	319.8	97.5	112.8	81.5	35.0	16.5
MSD (P = 0.05)	NS	75.8	85.6	NS	44.4	NS

*Applied June 24, 1986

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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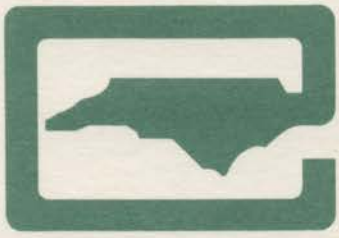

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