26TH ILLINOIS TURFGRASS CONFERENCE

North Central Turfgrass Exposition
December 10 - 12, 1985

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A SIMPLE TISSUE CULTURE APPROACH TO IDENTIFYING DISEASE RESISTANT TURFGRASS

Mary Ann Smith

Summer patch is a devastating fungal disease which causes severe root and crown rots on bluegrass (*Poa* spp.). The disease is caused by *Phialophora graminicola*. The fungus responsible can act in concert with another, separate fungal organism, *Leptosphaeria korrae*, the causal organism of necrotic ring spot on turfgrasses, and combined they create a complicated disease interaction which is potentially even more destructive: the misnamed "Fusarium Blight Syndrome." As a result, two problems exist on turf, and combined they contribute to a poorly understood complex that for years has defied study. As a result, this complex has actually been blamed on *Fusarium*, the wrong causal organism.

Not only do the interactions between the two organisms make the problem very difficult to study, but the scientist has no control over this disease for field testing. Any variation in soil type, drainage, or other environmental factor will change the expected expression of disease symptoms, and the disease will not develop quickly enough after artificial inoculation to allow selection of resistant grasses. The fungus causing the disease called "summer patch" is actually the asexual stage of the same organism that causes an equally serious disease on bentgrass as well as take-all patch on wheat. Similar problems in developing effective control for these diseases also exist.

These complications impede the work of breeders trying either to find superior selections without the disease problems or to formulate effective control measures. Traditionally, the disease defies productive study. In addition, a population of soil-borne bacteria (pseudomonads) acts as an antagonist to the fungi. The bacteria are triggered to multiply and build up their population by some signal which comes directly from the grass and pathogen interaction (Figure 1a). After a period of time, the bacteria can build to a sufficient population to effectively suppress the pathogenesis of the fungi, and give real protection to turfgrass from this disease (Figure 1b). One can't afford to wait for this biological control to work on high maintenance golf greens or in a landscape space, but it would be a benefit to select for bluegrass genotypes which are resistant to the pathogen and supportive of bacterial colonization. A selection of bluegrass may seem "resistant" to disease attack because it somehow is able to ward off the fungi, or it may show no symptoms because it is very receptive instead to the bacteria, and they are preventing any damage. In addition, both may be operative in a "resistant" grass; some genetic defense against fungi and receptivity to bacteria that colonize the rhizosphere.

An interaction exists between two different fungal pathogens, between bacteria and fungal pathogens all acting on grasses, and multiple interactions with soil factors that compound the problem of trying to understand the disease and conquer it. These combined factors make the disease complex extremely frustrating to work against. Clearly, field testing is not an efficient or effective method for finding superior turfgrasses with resistance.

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The complexity of the disease problem and the slow progress possible with field experiments warrants a simplified, alternative approach. The ideal procedure would be to isolate the bluegrass in a defined, controlled environment, without the complications of either a soil rhizosphere or competing microorganisms (Figure 1c). Then, a specific pathogen could be introduced with precision to the plant and observations could be made without interference about the mode of pathogenesis, the reason for protection, or the plant attributes that influence disease susceptibility. That is exactly what can be done by developing a microculture system for bluegrass. An ideal analog of the field situation can be provided: growing grass plants in an isolated environment on a medium we have defined and standardized, so that many of the complicating variables which have precluded research progress are eliminated.

When a specific organism of our choice is added back, the way the disease attacks can be easily studied. If a grass shows some resistance to the disease, the exact reason can be determined, as well as work directed in a manner to breed bluegrass to fortify the mode of resistance. Two separate traits (or their combination) are desirable, which can contribute to a superior bluegrass line: ability to resist fungal attack because of some unique plant character controlled by its genotype, or a bluegrass that is receptive to rapid buildup of bacteria in the rhizosphere, and is then indirectly afforded some protection. This study was initiated by considering the fungus responsible for summer patch, but the study could easily be extended to other pathogens and disease complexes.

The objectives in this present study are (1) to establish a bluegrass microculture system using differentiated tissues (whole grass plants, blades [phytomers] or roots) in culture and undifferentiated (callus) cultures: the microorganisms of interest must be amenable to manipulation in this artificial environment as well; (2) to correlate the level of field susceptibility to summer patch with a disease reaction observed *in vitro*; (3) to use this microculture analogy of a field disease to screen and select for resistant bluegrasses, without resorting to the slow, tedious, and usually inconclusive traditional methods of field evaluation; and (4) to generate somaclonal variants from the microcultures in order to serve as another source of potential breeding material. Whether selection for some natural resistance in grasses while they are in the microculture form is in view, or actually creating new and potentially superior selections through the microculture process itself, the objective is to obtain a grass plant that has demonstrated superior and desirable traits in culture, and acclimate it back to the greenhouse and eventually the field, so that a new selection that is of immediate use to the whole plant breeder is produced.

Establishing a microculture system to effectively study the disease has been the major focus of the work in this early stage of the project. The bluegrass microcultures must be available in whole plant, organ and callus form before a useable system for disease investigation is feasible. This is an important point, since any preceeding work in turf tissue culture has almost exclusively focused on only callus cultures of grasses. Whole plant or blade (shoot) cultures are differentiated tissues, similiar to the plant in the field, but in miniature. They are genetically uniform and will remain so all the time they are in culture, so a good, stable source of test plants for study exists. Because they are replicas of field plants, they will respond to a disease in the same way: a foliar symptom in the field will be evident and will be mimicked in cultured roots. Plants held in

this form can be quite rapidly subcultured and generated for study, or propagated, transferred to the outdoor environment, and made avaiable to breeders. Grasses cultured in whole plant form are available for excellent parallel experiments in culture and the field or greenhouse. A clump of grass can be divided and half grown in culture while the other half is adapted to grow outside the culture tube and be tested in a growth chamber simultaneously. The reactions of identical clones can then be compared. It is possible to grow only the root systems of the grasses isolated in culture without the blades or crowns: this would be classified as an "organ culture." In this case, concern is given to a pathogen that attacks roots, and the opportunity often arises to more closely observe the interaction between the fungus and roots without complications from other tissues that may interact.

Callus cultures are used to prevent loss of the defined structure of the plant, and any associated disease reaction. However, it is at the callus level that the tissues have the opportunity to change genetically, and selection for superior grass variants can be made. Screening for disease, even at the callus level, has been successful in other crops, even though the tissue infected by a pathogen that is under study is completely different than it would be in nature. Using callus, the opportunity exists to perform some manipulations on the bluegrass that can stimulate more variability and generate possibly more superior types by applying selective pressure. One can take the opportunity to do some preliminary evaluations at this level of development, when literally thousands of potentially useful grass genotypes can be screened at one time and from the callus clumps, regenerating back whole plants which can contribute positively to field or greenhouse breeding efforts. One can also go one step further and experiment with plant protoplasts, or isolated cells without cell walls, which are a tool for more sophisticated genetic engineering methods using bluegrass, and a source of more useful breeding material. All of these evaluations and selections can take place much more rapidly than any similiar tests in the field.

Some variables at the micro-level impact on the form of microcultured grass that can be maintained in culture:

The medium. Whether callus is obtained or some differentiated form of the bluegrass when it is put in culture depends on the medium composition. If a high concentration of auxin hormones is incorporated into the medium, the tissue turns to callus; that concentration is lowered, roots can be maintained, and with a good blend of auxin and cytokinin, one can be reproductively culture whole grass plants.

The environment. Experiments have been conducted with temperature and light regimes to optimize culture in each of these three forms, and have shown that callus grown in 100 percent darkness actually will grow more rapidly, and in a more loose, friable form than in the light. This dark-grown is actually more useful as a source of plant tissue for disease assays, or protoplasts, or to regenerate whole plants back from the callus state.

The explant. The part of the parent plant that is used to start a new microculture has a strong influence on the kind of culture that will be created. When starting with grass caryopsis, especially immature caryopsis, the tendency exists to get more rapid plant or callus formation than if a segment of crown from a greenhouse or field plant was utilized.

A standardized, workable microculture system for bluegrass in all three of the culture forms has now been completed. Uniform tissue can be rapidly generated for screening and testing or inducing superior grass genotypes in culture, and regenerating whole field-ready plants that are then available to a breeder for further work. Testing has also begun on the pathogen (isolated from all other organisms) in the culture environment to make sure that it is able to grow normally in vitro. A whole-plant growth chamber assay for disease susceptibility has been utilized. In this "cone-assay," the selections made at the microculture level can be introduced into the greenhouse/growth chamber environment and very rapidly measured (28-day turnover) in terms of resistance; the disease can be produced consistently. Selections of variant breeding cannot be accomplished in the growth chamber assay, but it provides a fairly rapid, specific check to verify that the resistance seen at the micro-level holds up in a natural environment. There is no such check available in the field, where the disease can't be controlled for effective testing.

This research is currently in the final stages of preparing multiple uniform microcultures of bluegrass varieties with known levels of resistance and susceptibility to summer patch disease--specifically "Adelphi," which has demonstrated some field resistance to summer patch and the combined problem caused by both the summer patch and necrotic ring spot fungus, and "Fylking," which is quite susceptible to damage. Their differential reactions to the fungi have been verified using the growth chamber assay, mentioned earlier. Testing both the causal fungus responsible for summer patch, and the grasses in all of the three microculture forms will soon begin. Once the determination of the kind of response to be expected of a "resistant" grass in culture is made, one can use the rapid assay to select, isolate, and produce whole plants of immediate use in landscape situations.

Parallel experiments with wheat, attacked by the same or closely related fungus, have helped to verify the kinds of responses seen with bluegrass. So the microculture system is not only a feasible method, but perhaps the only way to make substantial progress towards control of a severe and challenging turfgrass disease.

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Figure 1a. In nature, the patch diseases involve a complex interaction between grasses, fungal pathogens, and bacteria that are actually antagonistic to the fungi.

Figure 1b. Once the bacterial populations build to sufficient levels (years) the grass may be protected from the fungal pathogens' destructive symptoms.

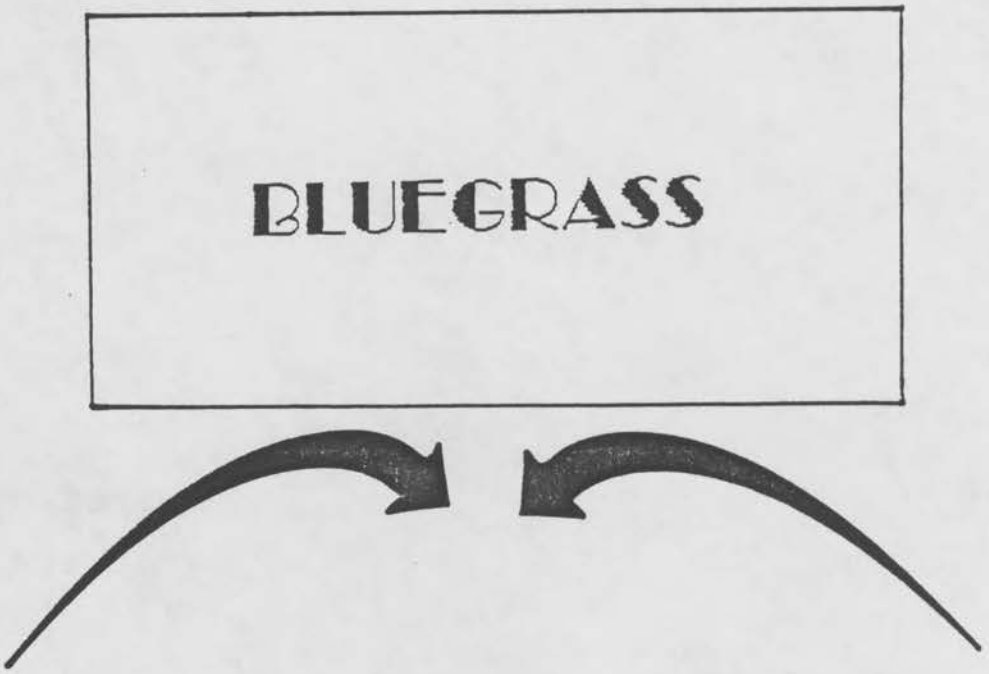

Figure 1c. By isolating the grass from outside influences (as in microculture) the effect of only one microorganism at a time can be observed.

BREEDING FOR DISEASE RESISTANCE IN COOL SEASON TURFGRASSES

William A. Meyer

There has been a great increase in breeding work on cool season turfgrass cultivars since the Plant Variety Protection (P.V.P.) Act was signed into law in December, 1970. This law, which is similar to the Plant Patent Law except that it covers sexual and asexual species, permits the developer of a new cultivar to exclude others from any unauthorized reproduction or marketing. This does not exclude others from using protected cultivars in further breeding work.

Presently there are approximately five U.S. universities, fourteen U.S. companies and ten foreign companies involved in the development of cool season turfgrasses. Kentucky bluegrass (*Poa pratensis* L.), perennial ryegrass (*Lolium perenne* L.), tall fescue (*Festuca arundinacea* Schreb.), Chewings fescue (*F. rubra* L. subsp. *commutata* Gaud.), slender creeping fescue (*F. rubra* L. subsp. *trichophylla* Guad.), creeping or spreading fescue (*F. rubra* L. *rubra* Guad.), hard fescue (*F. longifolia* Thuill.), Sheeps fescue (*F. ovina* L.) and creeping bentgrass *Agrostis palustris* Huds.) are the most important northern turfgrasses. All of these species reproduce sexually and are cross pollinated except for Kentucky bluegrass, which reproduces mainly by means of apomixis.

A new turfgrass cultivar must be distinct, uniform, and stable during its reproduction process in order to be protected under the P.V.P. Act. The plant breeder is responsible for describing all of the performance and morphological characteristics of a new variety compared with the standard varieties. All of this information is considered by P.V.P. officials in determining the distinctness of a new cultivar. From a practical standpoint, a new cultivar must be both easy to establish and an economically efficient seed yielder.

HISTORY OF KENTUCKY BLUEGRASS

Kentucky bluegrass is the most important turfgrass in the northern half of the U.S. All of the cultivars used prior to 1970 were derived from composites collected from naturalized stands in the midwest or individual apomictic clones found in old turf areas. Merion Kentucky bluegrass originated from a single plant collected in 1936 from Ardmore, Pennsylvania (8). This was the first cultivar with a real turf-type growth habit and improved resistance to leaf spot caused by *Drechslera poa* (Baudys.) Shoem. and *Bipolaris sorokiniana* (Sacc. in Sorok.) Shoem. (*1,4,11*). All other cultivars available until the late 1960's were highly susceptible to leaf spot when maintained at close mowing and high fertility.

HYBRIDIZATION OF KENTUCKY BLUEGRASS

Kentucky bluegrasses produce seed both sexually and asexually by a process called "apomixis." Seed formed by apomictic reproduction is genetically identical to the mother plant. Apomixis is therefore an excellent means of maintaining the genetic purity of a cultivar from one generation to the next. It also makes the crossing and subsequent selection of Kentucky bluegrasses a difficult process.

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Clones of Kentucky bluegrass vary as to their level of apomixis. Merion has a level of apomixis of 96 percent or more, and A-20 has a apomixis level of around 25 percent or less. This high level of apomixis of Merion made possible the stable reproduction of this cultivar. A-20 has been increased mainly by vegetative means because of its high level of sexuality (8).

The greatest breakthrough in the breeding of Kentucky bluegrass occurred at Rutgers University in the late 1960s (6). Dr. C. Reed Funk and his associates developed a greenhouse crossing technique using clones with various levels of sexuality, which resulted in the many F_1 hybrids. Fortunately 14 percent of these F_1 hybrids had recovered the apomictic mode of reproduction. The also found that approximately 16 percent of the clones collected from old turf areas were considered highly apomictic (6).

IMPROVED TURF-TYPE KENTUCKY BLUEGRASSES

The cultivars Adelphi, Able I, Bonnieblue, Challenger, Majestic, Nassau, Eclipse, Midnight, Bristol, and America have resulted from the hybridization work at Rutgers University. Touchdown, Columbia, Glade, Plush, Ram I, and Mystic are cultivars developed cooperatively by Rutgers University and other organizations. Nugget, A-34, Baron, Blacksburg, Victa, Cheri, Birka, Georgetown, Parade, Haga, Fylking, Sydsport, Wabash, and Shasta were also collections from old turf areas developed by other U.S. and European organizations.

All of the above mentioned cultivars are low growing cultivars with resistance to leaf spot comparable to Merion and more resistant to stripe smut caused by *Ustilago striiformis* (West.) Niessl than Merion, which is highly susceptible (8). The cultivars Baron, Cheri, and Victa were originally thought to have good resistance to stripe smut in New Jersey tests and were later found, after years of testing, to be moderately susceptible (8). Determining the level of stripe smut resistance of a new Kentucky bluegrass cultivar adds 3 to 4 additional years to the development time needed for a new cultivar.

COMMON TYPES OF KENTUCKY BLUEGRASSES

Park, Arboretum, Argyle, Palouse, S-21 Geary, Kenlue, Delta, Common, Delft, Troy, South Dakota, and Piedmont are erect cultivars with a rapid vertical growth rate and high susceptibility to leaf spot. Newport, Prato, and Cougar are moderately low-growing cultivars susceptible to leaf spot (8). All of the above cultivars perform better when mowed at 6 cm or higher. When common bluegrass is purchased on the market, it usually consists of one of the above cultivars.

Park and Kenblue are the most genetically diverse cultivars and will perform better under low maintenance conditions than other common types or new turf-type cultivars.

FUSARIUM BLIGHT OF KENTUCKY BLUEGRASS

Fusarium blight caused by *F. roseum* f. sp. *cerealis* of *F. tricinctum* f. sp. poae (2) can cause severe damage to Kentucky bluegrass cultivars that are resistant or susceptible to leaf spot and stripe smut. Work by Smiley (19) has shown that other soil-borne fungi are involved in the *Fusarium* blight syndrome. When

these organisms are present, Smiley re-names the diseases "summer patch" and "necrotic ring spot." This disease is most serious under conditions of drought stress, high nitrogen fertility and heavy thatch accumulation.

The cultivars showing the best resistance to this disease tend to be those cultivars that are less aggressive sod formers. In tests in Southern California and New Jersey (7), the cultivars Adelphi, Columbia, Parade, Rugby, Banff, Glade, and Sydsport have shown improved resistance, while Park, Fylking, and Pennstar have been most susceptible.

In our development system, the most promising cultivars are seeded in southern California where *Fusarium* blight is usually an annual occurence. The reaction to *Fusarium* blight can be observed within 8 months of planting.

LOW MAINTENANCE KENTUCKY BLUEGRASSES

All of the rust diseases and dollar spot (*Sclerotinia homeocarpa* T. Bennett) are the most serious low maintenance diseases of Kentucky bluegrass. Nugget is very susceptible to dollar spot, while Merion, Glade, Sydsport, Touchdown, Baron, Victa, Cheri, Ram I, and Plush have shown moderate susceptibility (8). The other turf-type cultivars have shown moderate or better resistance to dollar spot. This disease could become quite serious on susceptible cultivars in the future if the cost of nitrogen fertilizer continues to rise.

In the midwestern and northeastern U.S. and in southern California stem rust (*Puccinia graminis*) can seriously damage Merion, Birka, Touchdown, and Baron under low fertility (4,8). Adelphi, Majestic, Columbia, Bristol, Ram I, and Midnight have shown improved stem rust resistance (8).

SPECIALTY USES OF KENTUCKY BLUEGRASS

Many of the turf areas in the northern U.S. are partially shaded. Powdery mildew (*Erisiphe graminis* DC) and leaf spot are the most serious diseases in shade (1). A-34, Bristol, Glade, Nugget, Touchdown, Able I, and Birka have shown good resistance to some fo the races of powdery mildew (8) and perform better in the shade than other cultivars.

When Kentucky bluegrasses are maintained at short cutting heights and managed as a golf course tee or fairway under intense management, they are usually unable to compete with *Poa annua*. Touchdown and A-34 were two cultivars able to compete with *Poa annua* under this type of management in an Illinois study (16). These are very aggressive cultivars with high, competitive abilities. They can dominate other cultivars in blends, and if they are managed at higher, non-demanding cutting heights, they can develop thatch at a rapid rate.

TURF-TYPE PERENNIAL RYEGRASSES

All of the perennial ryegrasses available prior to 1960 were developed for forage rather than turf. In 1967, Manhattan perennial ryegrass was released as the first improved turf-type cultivar. It is fine textured, leafy, and persistent in turf, with improved mowability. Pennfine was released later and had better summer performance than Manhattan but was less cold hardy (9).

Through the 1970's many new commercial cultivars of turf-type ryegrasses have been developed. The list includes Citation, Omega, Derby, Diplomat, Yorktown II, Birdie, Omega, Regal, Fiesta, Dasher, Blazer, Loretta, Belle, Pennant, Premier, Barry, and Elka (5).

More recently further development work has resulted in the release of some new varieties that have improved performance. The cultivars Prelude, Palmer, Gator, AllStar, Tara, Manhattan II, Citation II, Repell, Omega II, Birdie II, and Cowboy are some examples (5,18).

These turf-type ryegrasses have performed well over a wide range of soil conditions. They have excellent wear tolerance and the ability to survive in compacted soil situations better than other turfgrass species. Their excellent seedling vigor and persistence, and ability to tolerate close mowing and weed competition make them valuable components in mixtures with Kentucky bluegrass for athletic situations.

BREEDING FOR BROWN PATCH AND NET BLOTCH RESISTANCE IN PERENNIAL RYEGRASS

Since perennial ryegrasses are a cross-pollinated species, recurrent selection can be used to improve disease resistance. In our breeding program in cooperation with Rutgers University, we have been able to use recurrent selection in conjunction with single-plant turf progeny tests to improve the levels of both net blotch, caused by *D. siccans* (Drechs.) Shoem, and brown patch (*Rhizoctonia solani* Kuhn) resistance in ryegrass populations (5,18). Some of the new cultivars from this program and other breeding programs with improved resistance to both of these diseases are Prelude, Palmer, Premier, Citation II, Tara, Omega II, AllStar, Repell, Birdie II, Manhattan II, and Cowboy (5,18).

LOW MAINTENANCE DISEASES OF PERENNIAL RYEGRASS

Dollar spot, crown rust (*Puccinia coronata* Cda.), red thread caused by *Laetisaria fuciformis* (McAlp.) Burdsall, and stem rust (*Puccinia graminis* Pers.) can severely damage perennial ryegrasses grown under low fertility.

The cultivars Citation, Regal, Premier, Repell, Birdie II, Citation II, Palmer, and Prelude are examples of varieties that have shown improved resistance to certain strains of red thread and dollar spot (5,8,18). The inoculation of mowed clonal space plants of ryegrass with red thread in Oregon has shown a wide variation in the reactions of plants to the indigenous strains of red thread. Hopefully this technique of screening clones will result in the development of synthetic varieties with high levels of resistance to this disease.

The cultivars Elka, Birdie II, Citation II, Prelude, Palmer, Cowboy, Blazer, Premier, Repell, Manhattan II, and Pennant have shown improvements in resistance to crown rust, while Regal is quite susceptible (18). This is another disease that has been reported to have many different races which could affect variety performance.

Stem rust is also a serious disease in the seed production fields in western Oregon, causing yield reductions of up to 93 percent. A breeding program was started in 1975 to incorporate three sources of stem rust resistance found in

germplasm collected in old turf areas into some of the improved turf-type perennial ryegrass varieties (15). The varieties Manhattan II, Citation II, Birdie II, Omega II, and Cowboy were developed as a result of this program and have shown good resistance to stem rust in seed production fields and turf (17,18).

OTHER DISEASES AND PESTS OF PERENNIAL RYEGRASS

Pythium blight is still a serious disease of perennial ryegrasses, especially under poor drainage conditions. No resistance to this disease has been reported for perennial ryegrass. Fortunately, the new turf-type cultivars have the ability to rapidly recover from the disease.

The turf-type perennial ryegrasses are unique in that they have never been reported to form thatch. They are also useful in mixtures with Kentucky bluegrass to reduce the incidence of *Fusarium* blight. In our tests in southern California the addition of 15 to 20 percent turf-type perennial ryegrass in a Kentucky bluegrass mixture was an effective control for *Fusarium* blight.

Recently, reports have shown that some of the present perennial ryegrass cultivars are systemically infected with the endophytic fungus *Epichloe typhina* (Fr.) Tul. (12). The cultivars Repell, Regal, Citation II, and Pennant were found to contain over 80 percent endophyte content from analysis of seed. The varieties Birdie II, Cowboy, Allstar, and Prelude were found to have over 55 percent endophyte content. This fungus is transmitted by seed from one generation to the next and is found widely in plants surviving in nature. In the future, this endophyte-enhanced pest resistance should become an important practical method of biological control for insects and other pests of new cultivars (12).

FINE FESCUES

The Chewings, slender creeping, creeping or spreading, hard, and sheeps fescues are the predominant species included in the open-pollinated fine fescue group. They form a very fine, dense turf and will maintain this density at low fertility. They will tolerate infertile, droughty, and acid soil conditions, moderate shade, and tree root competition. They will neither tolerate wet soils nor perform well in open sun at high nitrogen fertility and irrigation because of severe leaf spot damage caused by *B. sorokiniana* and *D. dicyoides* (1,10).

CHEWINGS FESCUE

This is a very low growing species producing only basal tillers and no rhizomes. They perform best in cooler regions of the U.S. and will tolerate close mowing. Jamestown and Banner are improved cultivars with better heat tolerance than older cultivars (10). These cultivars can be damaged by powdery mildew in the shade. Shadow is a new cultivar with improved resistance to powdery mildew. All of the new cultivars need better resistance to red thread and dollar spot. They are very dense, aggressive turf formers, which can be a disadvantage when they are used in mixtures with Kentucky bluegrass, by being too competitive and by rapid thatch accumulation. They combine better in mixtures with turf-type perennial ryegrasses, which are more competitive and help to keep a balance of species.

SLENDER CREEPING FESCUE

Dawson is the popular example of this group. It forms short, thin rhizomes and looks like a Chewings fescue. Dawson is more susceptible to dollar spot and more resistant to leaf spot than most other fine fescues. It has performed better than other fine fescues for the overseeding of dormant bermudagrass with a very good establishment rate.

CREEPING OR SPREADING FESCUES

These fescues have wider leaves than other fine fescues and produce long rhizomes. They will not tolerate a close cut, but have very good seedling vigor. Fortress, Ruby, and Ensylva are creeping types with less leaf spot, red thread, and dollar spot resistance than the best fine fescues (10). Flyer is a new creeping fescue cultivar with improvements in heat and disease tolerance. These cultivars have a more open growth habit than the other fine fescues and are more compatible in mixtures with Kentucky bluegrass than the other fine fescues.

HARD FESCUES

Biljart (C-26), Reliant, Spartan, Scaldis, Aurora, and Waldina are improved hard fescues. They are similar in appearance to the better Chewings fescues, but have a slower rate of vertical growth and improved heat tolerance. They have good resistance to red thread and leaf spot and improved tolerance to dollar spot. Their rate of establishment is slower than the other fine fescues. The limited commercial availability of hard fescues has been caused by their lack of burning tolerance in seed production, which limits the productive life of fields to 2 or 3 years. Breeding work has been done to select clones for use in synthetics that can sustain good seed head formation over a longer period of time in the absence of field burning. Aurora is a new cultivar that has been developed with improved seed production capabilities.

SHEEPS FESCUE

Sheeps fescue has had minor usage as a turfgrass. This has mainly been due to the very limited availability of commercial varieties. It is a very durable turfgrass that can be found in shade and growing in very poor soils. Many of the common strains have a wiry-grainy appearance and a blue-gray color. The cultivar "Bighorn" is a new sheep fescue with improved turf-forming ability. It has better establishment characteristics than hard fescues, especially under wet conditions, and also has improved leaf spot and red thread resistance.

TALL FESCUES FOR TURF

Tall fescue is a cool season grass best adapted to the transition zone of the U.S. This species can also do well in the great plains and Rocky Mountains when irrigated and is well adapted to the Pacific Northwest and California. The tall fescues require less irrigation to maintain active growth than do the Kentucky bluegrassses and perennial ryegrasses.

Alta and Kentucky 31 were the first cultivars developed for forage and turf uses (13). They both form a coarse, moderately open turf with a rapid rate of

leaf elongation. Fawn was a later forage development producing poorer turf quality than the above cultivars. Kentucky 31 has shown better tolerance of brown patch and *D. dictyoides* than either Alta or Fawn, which are quite susceptible. Chesapeake and Clemfine are new varieties which are similar in appearance to Kentucky 31.

Rebel, Falcon, and Olympic were the first new, moderately low growing, leafy cultivars developed for turf purposes (17). They have softer leaves and produce a denser, more persistent turf than the older cultivars. Also, they have shown improved resistance to brown patch and a more rapid recovery rate from disease damage. Olympic and Falcon were screened for resistance to crown rust prior to the final selection of parents in the breeder seed production field in western Oregon. Since tall fescue is another cross-pollinated species, recurrent selection has been used successfully to improve levels of disease resistance in populations.

Other more recent cultivars with improved resistance to both brown patch and leaf spot are Jaguar, Adventure, Bonanza, Cimarron, Apache, Arid, Mustang, and Houndog. The cultivars Apache and Bonanza have a darker green color than any tall fescues previously developed. Cultivars with even higher density and texture more similar to bluegrass should be available in the next three years.

CREEPING BENTGRASS

Penneagle creeping bentgrass was released in 1978 by the Pennsylvania Agricultural Experiment Station (3). This cultivar was developed after testing parental material for 15 years. The objective in developing this new putting green bentgrass was to have a broad genetic base without gross segregation of off-types, improved putting green quality, enough vigor to compete with *Poa annua* invasion and good disease resistance. In tests compared with Penncross, Seaside, and Emerald, this looks like an improved disease resistant putting green grass for the northern U.S. Penneagle has done very well as a grass for fairways. Another new creeping bentgrass cultivar being tested as PSU 126 was developed by Duich in Pennsylvania. This cultivar forms a very dense, fine putting surface when compared with other cultivars.

FUTURE NEEDS

There is an increasing demand for turfgrasses that require less energy and other natural resources for maintenance. This includes reduced mowing, irrigation, and fertilization. Cultivars are also needed that require less pesticide usage by being at least tolerant to serious diseases and insect problems and competitive with weedy species. There is a great need to eliminate diseases in seed fields through breeding work to improve the economics of seed production.

It is now well known that no single cultivar is sufficiently well adapted and disease resistant to be used in homelawn type turf in a monoculture. Blends and mixtures of Kentucky bluegrasses, improved turf-type perennial ryegrasses, and fine and tall fescues are now commonly used for new seedings and sod production. This trend places added demands on the turfgrass breeder to determine the compatibility of a new cultivar for blending and mixing with other cultivars and species to attain optimum long-term turf performance.

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POTENTIAL FOR BREEDING NEW ZOYSIAGRASS

Jack Murray

Zoysiagrass (*Zoysia* spp.) grows naturally and is used extensively as a turfgrass in temperate east Asia. It was introduced into the United States in the late 1800's but has had significant use as a turfgrass only in the past 30 to 40 years. Zoysiagrass is a warm season perennial grass that spreads both by rhizomes and stolons. The geographic area of adaption in the United States extends south from the coastal regions of New Jersey and west along the northern fringes of transition zone to the Great Plains. Its principle use has been in the transition zone where bermudagrass lacks sufficient winter hardness to be dependable.

Only token breeding efforts have been made to improve zoysiagrass. During the late 1940s and early 1950s, the USDA and USGA-Greens Section had the first and probably the most extensive breeding program. Since then, the limited germplasm available in the U.S. has been used to improve this species at several universities. However, the total breeding effort has been small compared with that of other turfgrass species. Only three recognized varieties have been released and utilized to any extent. "Meyer" the most extensively used variety was cooperatively released in 1951 by the USDA and the USGA-Green Section. "Emerald," a hybrid variety, was released by the USDA and the Georgia Agricultural Experiment Station in 1955. It is more adapted to southern conditions than Meyer. In 1963, "Midwest" was released by the Indiana Agricultural Experiment Station. It is more open, vigorous, and coarsely textured variety than Meyer. In 1985, "Belair" was released by the USDA at Beltsville, but it is not presently in production.

Zoysiagrass has been recognized for some time as a potentially important turfgrass in the United States. Studies have shown the species to have excellent heat, drought, and wear tolerance, generally moderate to good disease and insect resistance, good soil salanity and acidity tolerance, and better than average shade and cold tolerance for a warm season grass. Zoysia turf is extremely dense, competitive with broadleaf weeds and other grasses, and provides a high-quality, low maintenance turf. When zoysiagrass is compared with bermudagrass for use in the transition zone, it has better cold, wear, and shade tolerance, as well as a shorter dormancy period (for example, better fall and spring color).

Given Zoysia's good turf characteristics, why has it not been utilized more extensively in the United States? Its use has been limited mostly for two reasons: (1) difficulties in establishment and, (2) its long winter dormancy period. Present varieties must be propagated and established using vegetative material. Full coverage usually take two or more years. This relatively slow and expensive method has limited plantings of zoysiagrass to turf areas of high value. There are many more extensive and less valuable areas where zoysiagrass could be used if costs of establishment were reduced.

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Zoysiagrass becomes brown as days become shorter and temperatures become cooler in the fall and early winter. The length of this off-color or winter dormancy period varies from a few days in coastal areas to as long as 5 to 6 months in northern areas. This brown turf during the dormancy period is objectional on many sites.

Interest in zoysiagrass has increased sharply within the past few years. This renewed interest has been due, in part, to a consideration of low maintenance characteristics of zoysiagrass, coupled with increasing awareness of the need for turfgrasses that are more energy efficient in terms of water, nutrient, and maintenance requirements. The current direction of environmental awareness will continue and further restrict the use of chemical pesticides. The severe winterkill of bermudagrass in the transition zone, during the past few years, has resulted in consideration of the more winter hardy zoysiagrass as an alternative species. Perhaps, the most significant development has been the discovery of techniques to brake seed dormancy.

Drs. D.Y. Yeam and T.Y. Yu in South Korea found that scarifying seed with a strong alkaline solution, followed by a light treatment, broke seed dormancy and thus germination increased. This discovery dramatically increased the potential for developing seeded varieties that can be economically established: treated seed germinates (80 to 85 percent) in 8 to 12 days compared with 30 to 40 percent in several weeks for untreated seed.

Despite these major limitations on the use of zoysiagrass, sufficient progress has been made in the improvement of zoysiagrass through plant breeding. Although the present varieties are vegetatively reproduced, the *Zoysia spp.* are cross compatible, and interspecific hybrids have been produced. "Emerald" zoysiagrass is a hybrid between *Z. japonica* and *Z. teniufolia*. The hybrid carries the superior cold hardiness, faster rate of spread, and less thatchiness than *Z. japonica*, along with the finer leaves, denser turf, and dark green color of *Z. tenuifolia*.

Major objectives of the breeding program at the Beltsville Agricultural Research Center are to (1) improve the rate of establishment; (2) shorten the dormancy period (the two most limiting factors in the use of zoysiagrass); and (3) collect, identify, and preserve new germplasm sources. We are trying to increase the rate of establishment by selecting heavy seed yielding genotypes with good seeding vigor as well as genotypes with a faster rate of spread. We have been able to select five heavy seed yielding genotypes of *Z. japonica*. These selections have been in turf performance and seed yield tests for a number of years. In turf trials, they have not performed as well as "Meyer" but better than common *Z. japonica*. Seed yield has varied from 400 to 1,200 pounds per acre depending upon the genotype, year, and location of production.

Using the above heavy seed yield genotypes, we established a test to compare the turf quality of plots established by vegetatively planting the genotypes versus seeding their polycross seed. This test is now in its third year. In general, turf quality has not been quite as good from the polycross progeny as from the vegetatively established genotypes. However, the quality has been better than Korean common (the only commercially available seed) and would be acceptable for many turf areas. We believe that within the next few years we will be able to release a heavy seed yielding synthetic variety for commercial seed production in the U.S., or at least, provide germplasm to other breeders to develop seeded varieties.

Two approaches are being taken to overcome the objectional brown winter dormancy period of zoysiagrass. One approach is the selection of genotypes with late fall color retention and/or early spring green-up. Considerable genetic variability exists for these traits, and a significant shortening of the dormancy period should be obtainable. However, we can only go so far genetically because of the relationship between fall color retention, winter hardiness, and spring green-up. In general, as fall color is increased, winter hardiness and spring green-up is decreased.

The other approach to improving winter color is by mixing cool season grasses with the zoysiagrass. Results from tests since 1981 indicate that zoysiagrass can be successfully established with tall fescue, perennial rye, or Kentucky bluegrass, if seeded during the summer when temperatures are high enough (80°F or above) for rapid zoysiagrass germination. Establishment was best where one to two pounds of tall fescue and one pound of zoysiagrass were seeded per 1,000 square feet. This combination, mowed at one inch, has provided a uniform high-quality turf for the past four years. Perennial ryegrass and Kentucky bluegrass establishment have not been as good as tall fescue. Overseeding established Korean common zoysiagrass with cool season grasses has provided good winter turf without increasing winterkill of the zoysiagrass. However, perennial ryegrass is very competitive, and if it is not managed correctly, it will significantly reduce the stand of zoysiagrass within two to three years.

Research with mixtures indicates a good potential for selecting zoysia genotypes that would be more compatible with the cool season grasses than present varieties, especially with the tall fescues. We believe that these two species can be mixed and managed together successfully with overseeding occasionally to maintain uniformity.

In 1982, approximately 800 samples of zoysiagrass were collected in the Far East (for example, Japan, South Korea, Taiwan and the Philippines). Shortly after the plants were introduced, symptoms of a unique disease developed on a number of the plants. The collection was held in quarantine for over two years while we tried to identify the causal agent of this "exotic disease." Finally, it was discovered that the injury was caused by a previously undescribed eriophyid mite that has since been named *Eriophyes zoysiae*, a new mite species. Typical mite symptoms are white to yellow steaks and spots on newly emerged leaves, and rolling to the adoxial surface along one leaf margin. In heavy infestations, the entire rolled leaf margin and most of the leaf become chlorotic. If anyone observes mite symptoms under field conditions, we would appreciate being contacted and possibly obtaining a sample. This mite has not been reported before in the U.S.

The oriental collection was established in space-planted field nurseries in 1984. Observations to date indicate that there is much greater genetic diversity among the zoysiagrass than we had anticipated. A considerable period of time will be required to fully assess the agronomic and genetic benefits of this collecton. However, we feel the germplasm will provide the genetic diversity needed to develop improved varieties.

What is the potential of developing improved zoysiagrass varieties? The potential for improvement is certainly greater than ever before. Good progress is being made toward developing seeded varieties. Germplasm sources with improved agronomic traits are being isolated in several breeding programs. With continuing effort, I expect that within the next few years, several improved varieties for specific purposes will be available.

THE BREEDING AND DEVELOPMENT OF BUFFALOGRASS FOR GOLF COURSE AND HOME LAWN TURF

Terrance P. Riordan

As quality water becomes less available and more expensive, and as other management resources also become more expensive, turf managers are looking for new conservation methods for the future. Research has begun at the University of Nebraska--Lincoln on buffalograss, a warm-season species that requires less water, fertilization, and mowing than conventional turfgrasses. The main objective of this project is to develop a turf-type buffalograss for golf courses and home lawns. The project is being funded by the United States Golf Association, the University of Nebraska, and the Nebraska Turfgrass Foundation.

The project has been underway for just over a year, and already progress has been made. The first step in developing buffalograss as a turfgrass was to select and identify ecotypes from all available sources for evaluation. Seven hundred and eight plants have been collected throughout the Great Plains region which have been established in evaluation plots or are being held in the greenhouse to be planted next spring. These collections were selected on the basis of horizontal growth, density and uniformity of the stand, adaption to mowing or close grazing, drought resistance, adaption to compaction, short leaf height, and good color.

The second step, already underway, is to select the best plants for further evaluation and use in a breeding program. Forty eight plants have been selected for having qualities acceptable for turfgrass. Selection was based on density, horizontal growth, color, leaf height, seed production, inflorescence, height (tall females, short males), breeding ability, extended fall color, and overall aesthetic quality.

Buffalograss is an unusual grass to improve through breeding because it is dioecious (male and female flowers on separate plants). Therefore, both good male and female plants must be selected in order to make improvements through breeding. One interesting result so far is that good turf quality seems to be sex-linked to the female plant. During September, a test planting was made using three males and eight females. This planting was carried out to evaluate procedures and also to generate seed from the better female parents. In this planting, eight outstanding female clones are surrounded by three outstanding male clones. This plan allows for random pollination by the males and seed collection from each female.

Two other areas of study that may increase usage of buffalograss are seed and vegetative establishment evaluations. Buffalograss seed is relatively expensive and is slow to germinate and establish due to the multiple seeds being surrounded by a very hard bur. A seed treatment evaluation has shown that establishment can be enhanced by mechanically removing the seeds from the bur, by placing burs in a Waring blender for two seconds and then planting. Buffalograss establishment can also be enhanced by the use of pre-rooted plugs (plugs which are allowed to

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develop a root system in the greenhouse). In general, pre-rooted plugs have produced more stolons much sooner, established more quickly, and shown a better initial adaptation to transplanting (color-measurement) than non-prerooted plugs (plugs taken directly from established sod and transplanted directly into test plots). Because buffalograss has a fairly short growing season and establishment needs to be rapid, this method may open up a new way of marketing buffalograss.

Usually breeding and development programs are fairly long-term. However, the initial programs with buffalograss, along with the potential of vegetatively propagating an improved clone, make it possible to rapidly develop a new turf-type buffalograss. If such a clone is developed, the expense of watering, fertilizing, and mowing turf areas could be greatly reduced.

INVESTIGATIONS ON ANNUAL BLUEGRASS HEAT TOLERANCE

D. L. Martin and David Wehner

The decline in color and quality of annual bluegrass (*Poa annua* L.) turfs during the hot, dry summer months is a serious problem on many golf courses in the Midwest. In 1983-1985, research was conducted on the high temperature response of annual bluegrass. The specific objectives of this work were (1) to examine the variability in heat tolerance among populations of annual bluegrass from various locations in Illinois; (2) to determine if the heat tolerance of field grown annual bluegrass could be predicted using environmental data from the site; and (3) to examine the effect of the soil moisture regime on annual bluegrass heat tolerance. This research was conducted as a contribution toward the long-range goal of having a greater ability to predict and influence turfgrass heat tolerance.

EXPERIMENT I: HEAT TOLERANCE OF SELECTIONS OF ANNUAL BLUEGRASS FROM VARIOUS LOCATIONS IN ILLINOIS

Materials and Methods

Samples of annual bluegrass were collected from 14 locations in Illinois (Figure 1). A single tiller of annual bluegrass was used to generate a population of annual bluegrass to represent each collection site in heat tolerance testing. Ten tillers were selected from an annual bluegrass turf at the Horticulture Research Center at Urbana, Illinois to give rise to populations for use in evaluating heat tolerance within a single collection site. All tillers were multiplied in a greenhouse under conditions of regular watering, fertilization (0.125 lb N per 1,000 sq ft per week), and clipping (1 inch).

After adequate quantities of plant material had been produced, the selections of annual bluegrass were taken to the Horticulture Field Laboratory where plants were subjected to high temperature stress in a temperature controlled water bath for 30 minutes. The treatment temperatures used were in the range 104 to 118°F inclusive. Sydsport Kentucky bluegrass was included for comparative purposes. The annual bluegrass plants were then allowed to recover for 2 weeks in the greenhouse before all surviving and newly generated tissue was dried and weighed. The weights of treated plants expressed as a percentage of the weight of nontreated control plants provided a relative heat tolerance index for each selection. The heat tolerance index scale ranged from 1 to 100. The higher the index number, the greater the heat tolerance of the plants. A total of 4 screenings were conducted; one screening to examine variability in heat tolerance within the Urbana populations, and 3 screenings to examine variability among populations from various regions within the state.

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Results and Discussion

No significant differences in heat tolerance were found among the annual bluegrass selections from Urbana; this suggests that variability in heat tolerance among populations of annual bluegrass from within a site with relatively uniform topography, such as the Urbana site, is rather small. Several differences in heat tolerance were found among the annual bluegrass selections from different locations, with the selection from Danville being significantly more heat tolerant than the selection from Highland Park, in all three screenings (Table 1). Regression analysis was performed on the heat tolerance indices to determine if the relative heat tolerance of the selections could be predicted on the basis of the geographical location or upon long-term temperature data from the site of collection. No relationship was found between the heat tolerance index and either of these parameters. Table 2 shows the heat tolerance indices as well as the long-term mean temperature for July and latitude for 13 of the sites of annual bluegrass collection.

EXPERIMENT II: PREDICTING ANNUAL BLUEGRASS HEAT TOLERANCE

Materials and Methods

The monostand of annual bluegrass used in this study was established at the Horticulture Research Station at Urbana, Illinois in the fall of 1983. The stand was mowed at a 1 inch height of cut 2 to 3 times per week and fertilized with approximately 4 pounds of N per 1,000 square feet per year. Tensiometers were installed at the 2-inch depths so that irrigation could be properly timed.

Four sample plugs of turf were taken from the sampling area approximately every other week over the 1984 and 1985 growing seasons. Plants were evaluated for heat tolerance as discussed under Experiment I. The heat tolerance indices of plants treated at 104 to 113°F were averaged for each sampling date, and the means were analyzed using regression analysis involving on site parameters such as air and soil temperatures, rainfall plus irrigation, and soil matrix potentials from the tensiometers.

Results and Discussion

The best equation found for predicting the heat tolerance indices was a quadratic equation that used the mean maximum daily air temperature occurring during the two days prior to sampling and the mean combined daily rainfall and irrigation from the second through the fourth days prior to sampling. This equation was able to account for 78 percent (R^2=0.78) of the variation in heat tolerance indices occurring over the two growing seasons. The actual and predicted indices as well as the prediction equation are shown in Table 3 and Figures 2 and 3. Further research will be necessary to determine the accuracy of the equation generated during the two years of this work.

EXPERIMENT III: EFFECT OF SOIL MOISTURE ON ANNUAL BLUEGRASS HEAT TOLERANCE

Materials and Methods

This study was conducted on a portion of the annual bluegrass stand discussed in Experiment II. Two watering treatments were replicated 3 times as a 3.3 by 6.6 foot plot in a randomized complete block design. A black iron plate

was driven into the soil to form the boundaries of each plot. The plate, driven into the soil to a depth of 6 inches, prevented movement of water between the plots being maintained under the different treatments. The first treatment, designated the "wet treatment," maintained the turf under very moist soil conditions; whereas, the second treatment, designated the "dry treatment," maintained the turf under more moderate to dry conditions. Turf maintained under the wet treatment received 0.4 inches of irrigation water (by hand) approximately every other day, in addition to the amount of irrigation received by the general area on which the plots were situated. The wet treatment was not administered on dates when ambient rainfall exceeded 0.4 inches or on dates when irrigation of the general area exceeded 0.4 inches. The plots maintained under the dry treatment received ambient rainfall in addition to irrigation in the quantity delivered to the general area. In each plot, tensiometers were installed at the 2-inch depths to monitor the soil matrix potential. The study began on May 19, 1985.

The annual bluegrass maintained under the two watering treatments were screened for heat tolerance on a total of ten sampling dates. A single sample plug was taken from each plot on all sampling dates and screened for heat tolerance as discussed previously. Five of the sampling dates were conducted when the soil under the wet treated plots was more moist than that under the dry treated plots, while the remaining five sampling dates were conducted when the soil under both sets of plots was saturated at the 2-inch depth.

Quality ratings were taken for the turf on 9 dates during the study. In addition, the depth of live white-root system under each plot was measured. Eight inch-long soil cores were taken from each of the sample plots on 4 sampling dates and from the general area on 10 dates. The cores were soaked overnight in water to remove all soil and dead root system prior to root-length measurements.

Results and Discussion

Statistical analysis of the heat tolerance indices obtained from the annual bluegrass under the two watering treatments revealed that no statistically significant effect on heat tolerance occurred due to the differences in watering treatments. The heat tolerance indices of annual bluegrass under the dry treatment were, however, greater than those under the wet treatment on 9 of the 10 sampling dates. Mean heat tolerance indices from turf treated at 109 to 113°F are shown in figures 4 and 5.

Quality of annual bluegrass turf maintained under both treatments declined during the hot, dry portion of the growing season and increased late in the growing season. Annual bluegrass under the wet treatment usually demonstrated more satisfactory quality than that grown under the dry treatment. Differences in quality appeared to be due primarily to increased drought injury of turf maintained under reduced moisture. Quality ratings are shown in figure 6.

No statistical differences in the depth of the root system were present between the annual bluegrass maintained under the two watering treatments. The maximum depth of the annual bluegrass root system from the general area is shown in figure 7. The maximum depth of the root system declined as temperatures increased, with an increase in rooting depth associated with a decline in soil temperature later in the growing season. A strong negative correlation ($R = -0.83$) was found between the maximum depth of the root system and the mean maximum daily soil temperature (4-inch depth) of the period 2 weeks prior to core sampling.

On several dates during the warmest portion of the growing season, annual bluegrass plants showed severe wilting, even though tensiometer readings showed the soil to be saturated at the 2-inch depth and greater. The root system during this time of the season was confined to the upper inch of soil where soil moisture was insufficient to meet transpirational needs. The findings of this study illustrate the need for insuring that adequate soil moisture is present for annual bluegrass to meet transpirational needs during the warmest portion of the growing season, when the root system is at its shallowest.

Table 1. Mean Heat Tolerance Indices of Sydsport Kentucky Bluegrass and Several Annual Bluegrass Selections Evaluated in Experiment I[1]

Selection	Screening	Mean heat tolerance index[2] A	B	C
Centralia		59.4 bc	55.3 b-e	...
Danville		75.9 ab	60.0 bc	60.5 a
Decatur		64.2 b	44.5 ef	...
East Lansing		64.0 b	48.7 c-f	...
East Moline		54.9 bc	50.1 b-f	...
Harrisburg		60.9 bc	49.4 b-f	...
Highland Park		38.4 c	44.7 d-f	34.7 b
Kankakee		75.5 ab	51.0 b-f	...
Olympia Fields		69.5 b	49.6 b-f	...
Peoria		56.9 bc	57.1 b-d	...
Pickneyville		77.5 ab	44.3 ef	...
Rockford		...	55.9 b-e	...
St. Charles		...	61.5 b	...
Springfield		71.1 ab	40.9 f	...
Sydsport		94.1 a	74.8 a	57.5 a
Urbana		72.7 ab	52.3 b-f	63.5 a

[1]Heat tolerance indices are the plant recovery weights expressed as a percentage of the mean of the weights of two controls. Means in the same column with the same letter are not significantly different at the 5 percent level as determined by Fisher's Least Significant Difference Test.

[2]Values represent the mean of 4 replications. Means in screenings a, b, and c are the mean heat tolerance indices of plants treated at 104 and 108, 108 and 109, and 106 - 111°F respectively.

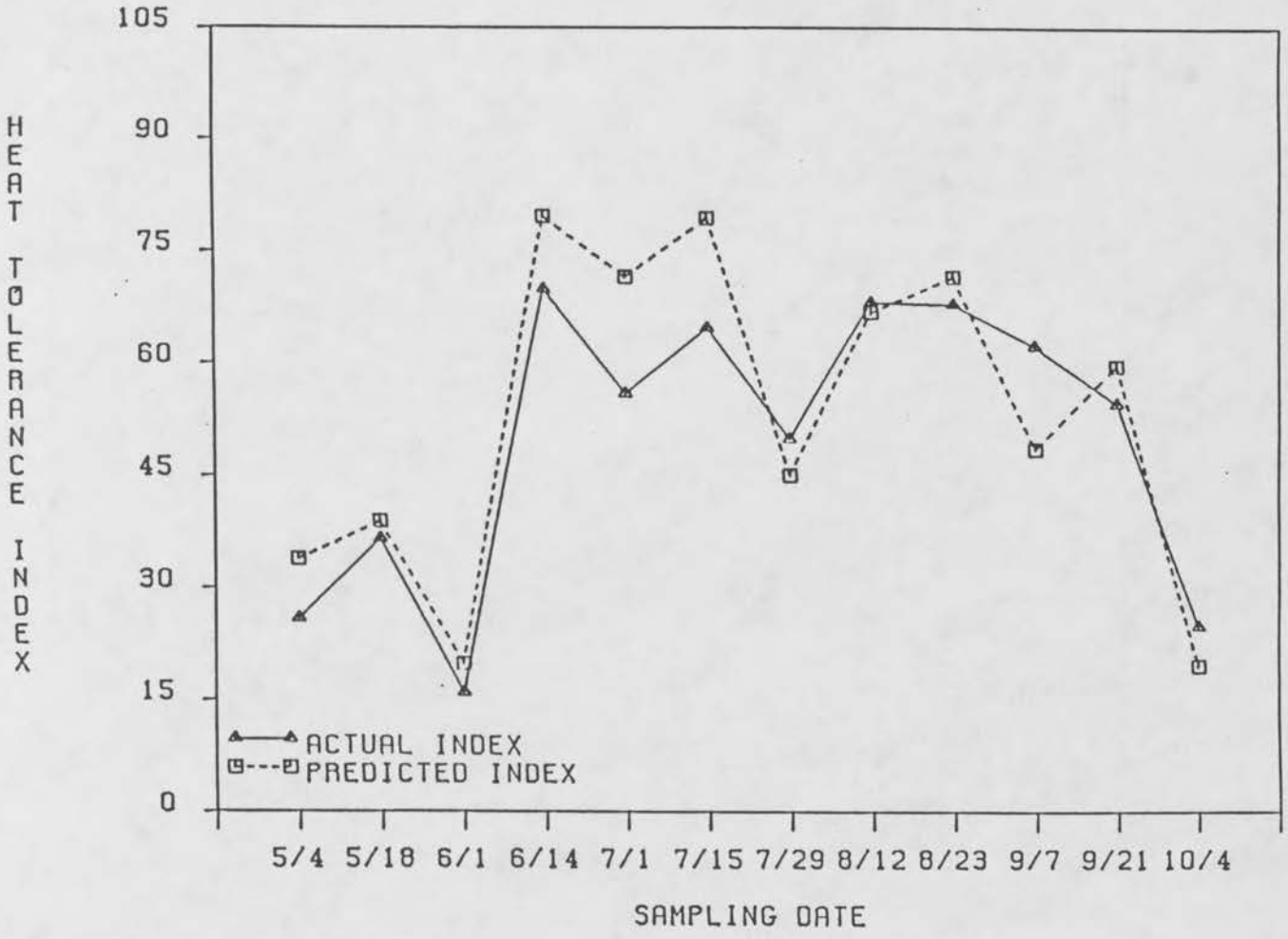
Table 2. Mean Heat Tolerance Indices, Temperature, and Geographical Data for 13 Sites of Annual Bluegrass Collection

Selection	Mean heat tolerance index[a]	Mean temp (F) for July[b]	Latitude[c] Min	Sec
Centralia	57.4	...	...	...
Danville	67.9	75.09	40	06
Decatur	54.3	76.50	39	50
East Lansing[d]	56.3	70.81	42	47
East Moline	52.5	74.50	41	27
Harrisburg	55.1	78.80	37	45
Highland Park[e]	41.5	71.91	42	21
Kankakee[f]	63.3	75.20	41	08
Olympia Fields[g]	59.5	73.51	41	30
Peoria	57.0	75.09	40	40
Pickneyville	60.9	...	...	...
Springfield	56.0	76.10	39	51
Urbana	62.5	75.31	40	06

[a]Heat tolerance indices were calculated by averaging the mean indices from heat tolerance screenings A and B. Indices from St. Charles and Rockford do not appear in this table as they were not evaluated in screening A.
[b]Unless otherwise shown, latitudes and long-term mean temperatures for July are from Anonymous (1980). Climatological Data-Illinois. U.S. Environmental Data Service. Volume 58.
[c]Latitude is that of the site where weather data was collected, not necessarily equal to the true latitude of the collection site for the selection.
[d]Long-term mean for July is that of Lansing, Michigan. Mean was obtained from Anonymous (1981). Weather of U.S. Cities. Volume 1. Gale Research Company. Detroit, Michigan.
[e]Long-term mean for July is that of Waukegan, Illinois.
[f]Long-term mean for July was obtained from Anonymous (1972). Climatological Data-Illinois. U.S. Environmental Data Service. Volume 73.
[g]Long-term mean for July is that of Park Forest, Illinois. Mean was calculated from data obtained in Anonymous (1952-1980). Climatological Data-Illinois. U.S. Environmental Data Service. Volumes 57-85.

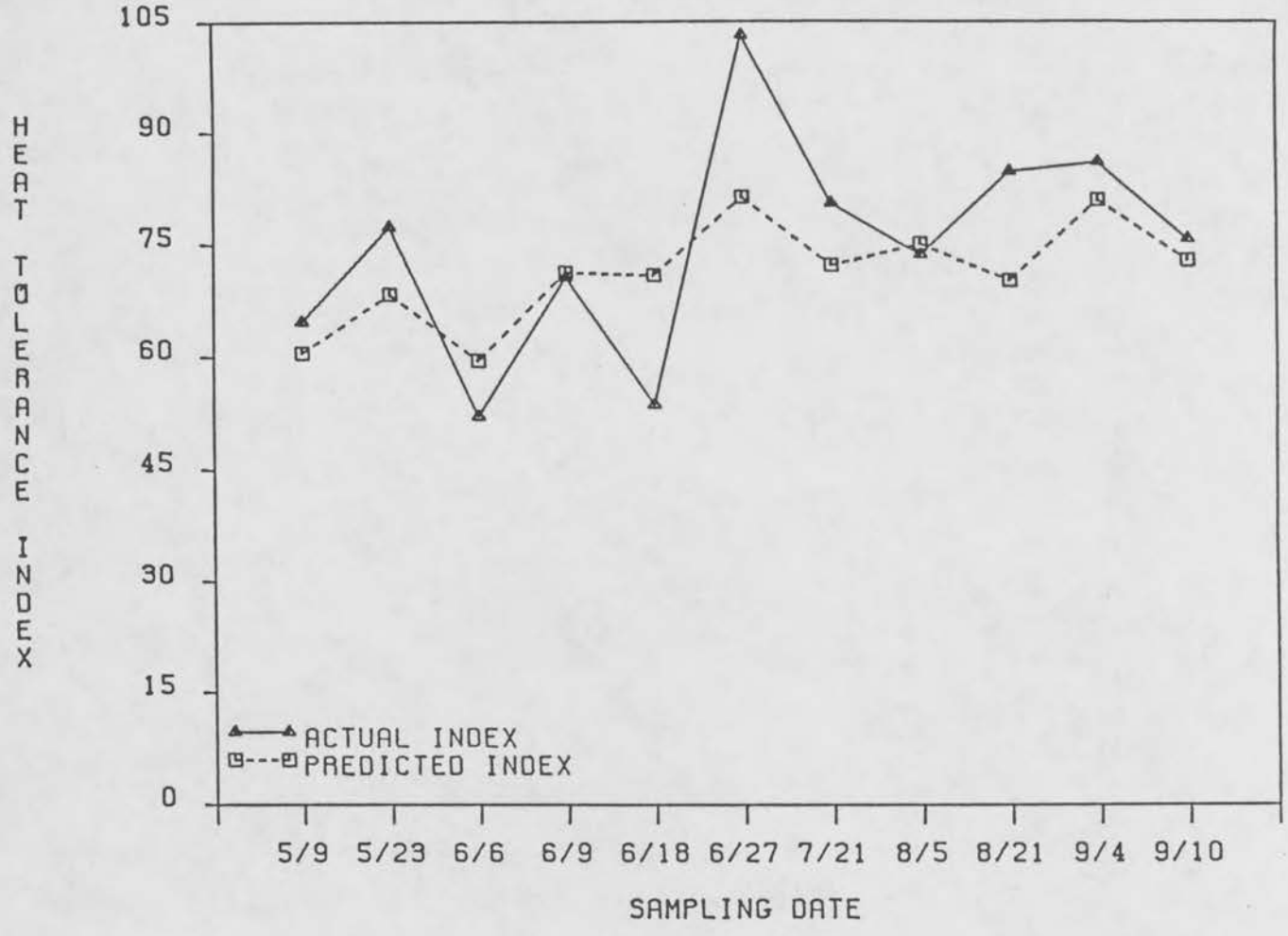
Figure 1. Locations of annual bluegrass collection sites in Illinois.

igure 2. Actual and predicted heat tolerance indices for the 1984 growing season. Predicted indices were calculated from an equation generated from analysis of heat tolerance indices obtained over the 1984 and 1985 growing seasons.[1]



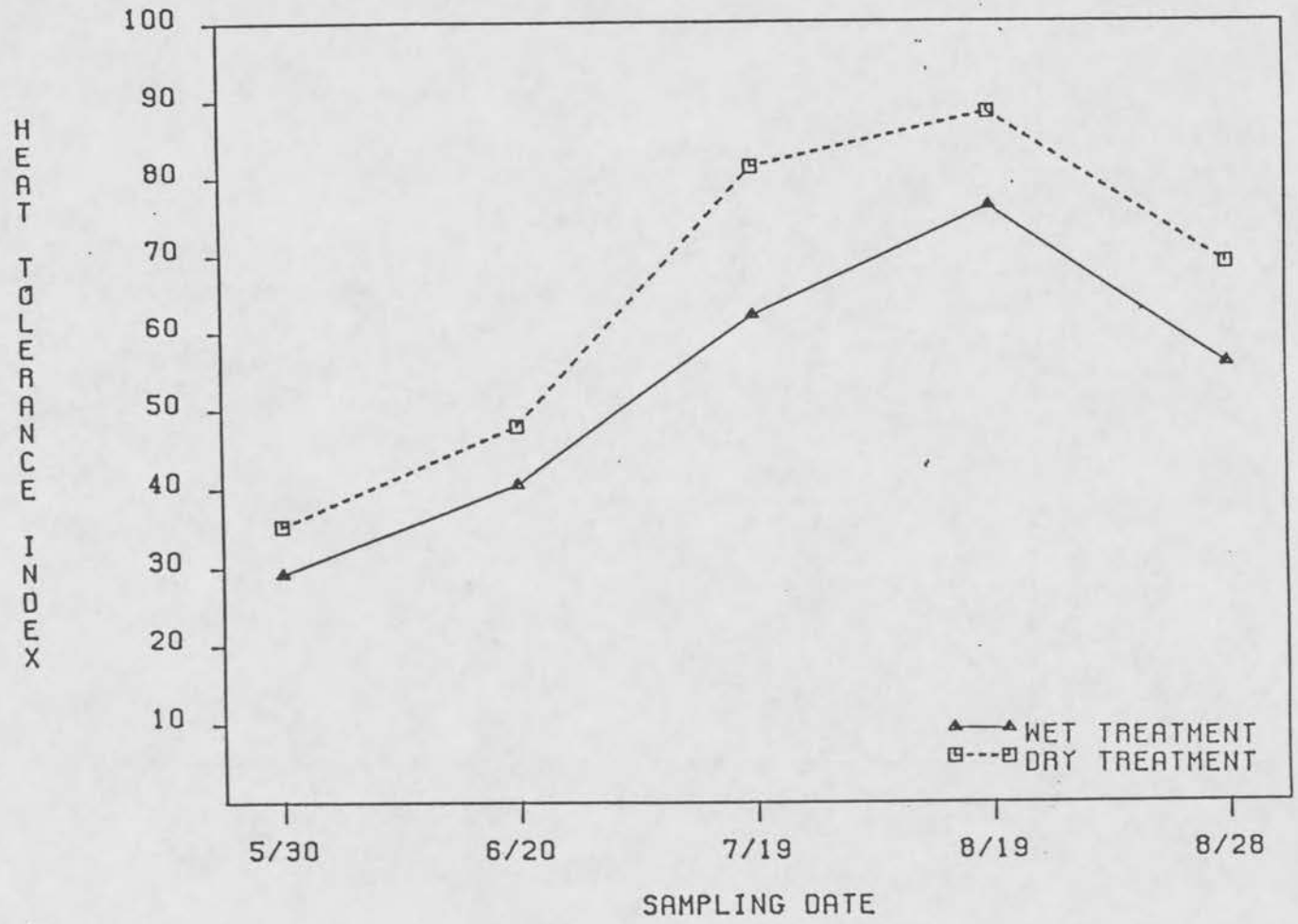
[1]Actual indices represent the mean of 4 samples treated in the temperature range 104 - 113 F.

Figure 3. Actual and predicted heat tolerance indices for the 1985 growing season. Predicted indices were calculated from an equation generated from analysis of heat tolerance indices obtained over the 1984 and 1985 growing seasons.[1]



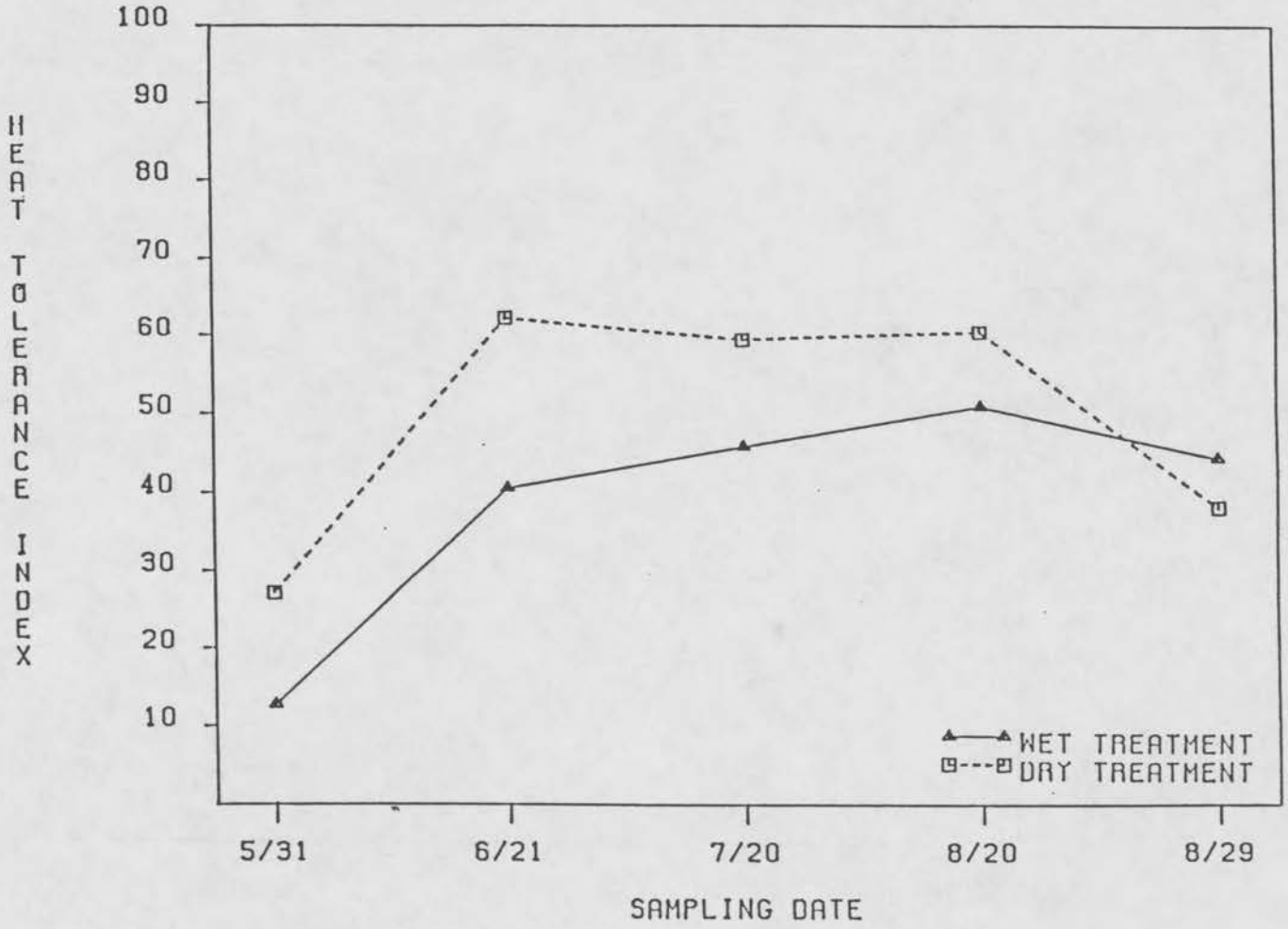
[1]Actual indices represent the mean of 4 samples treated in the temperature range 104 - 113 F.

Figure 4. Mean heat tolerance indices of annual bluegrass on 5 sampling dates when soil under dry treated plots was dryer than that under wet treated plots at the 2 inch depth.[1]



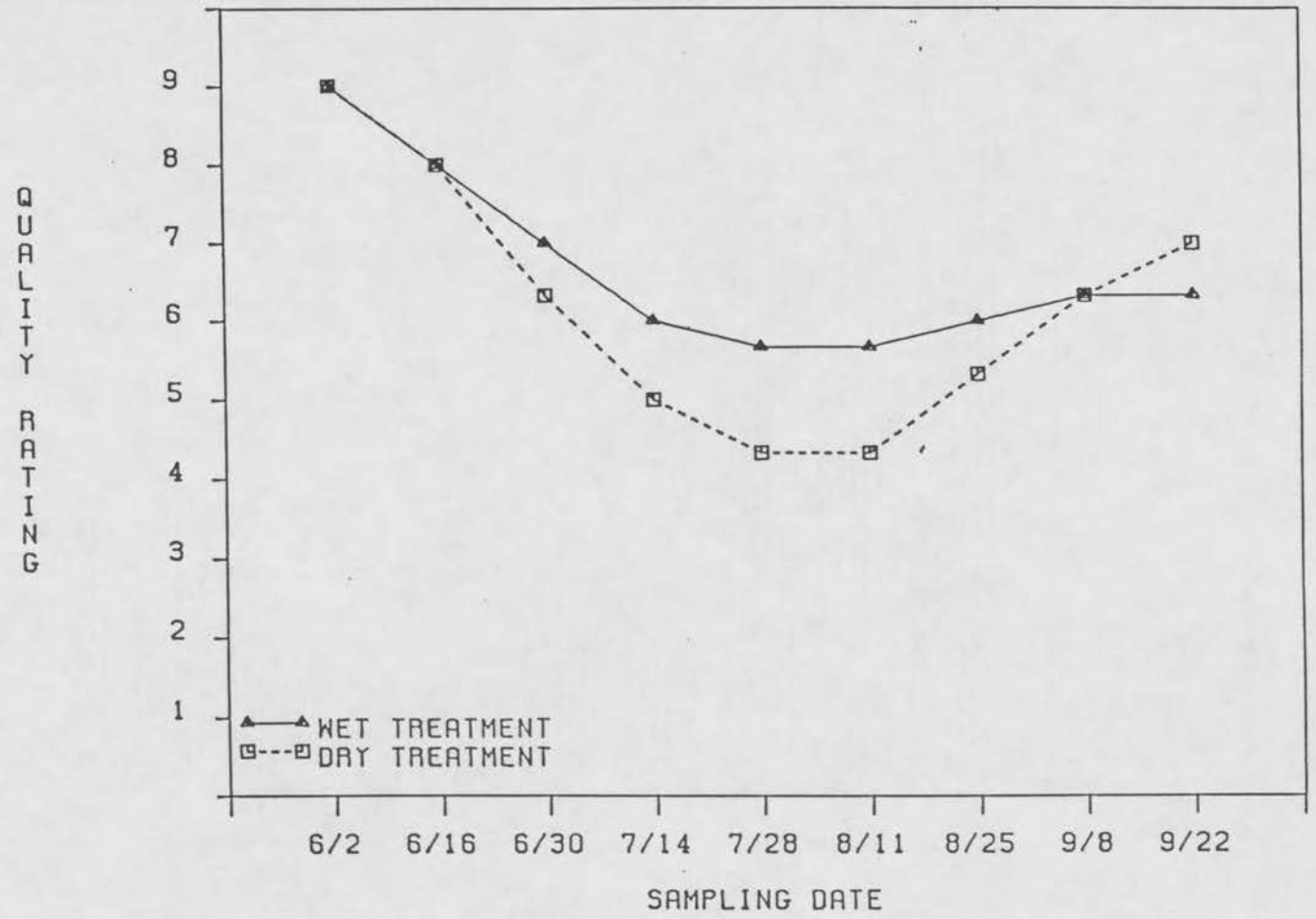
[1]All values represent the mean of 3 replications. Means are those of plants treated at 109 - 113 F.

Figure 5. Mean heat tolerance indices of annual bluegrass on 5 sampling dates when soil under both wet and dry treated plots was saturated at 2 inch depth.[1]



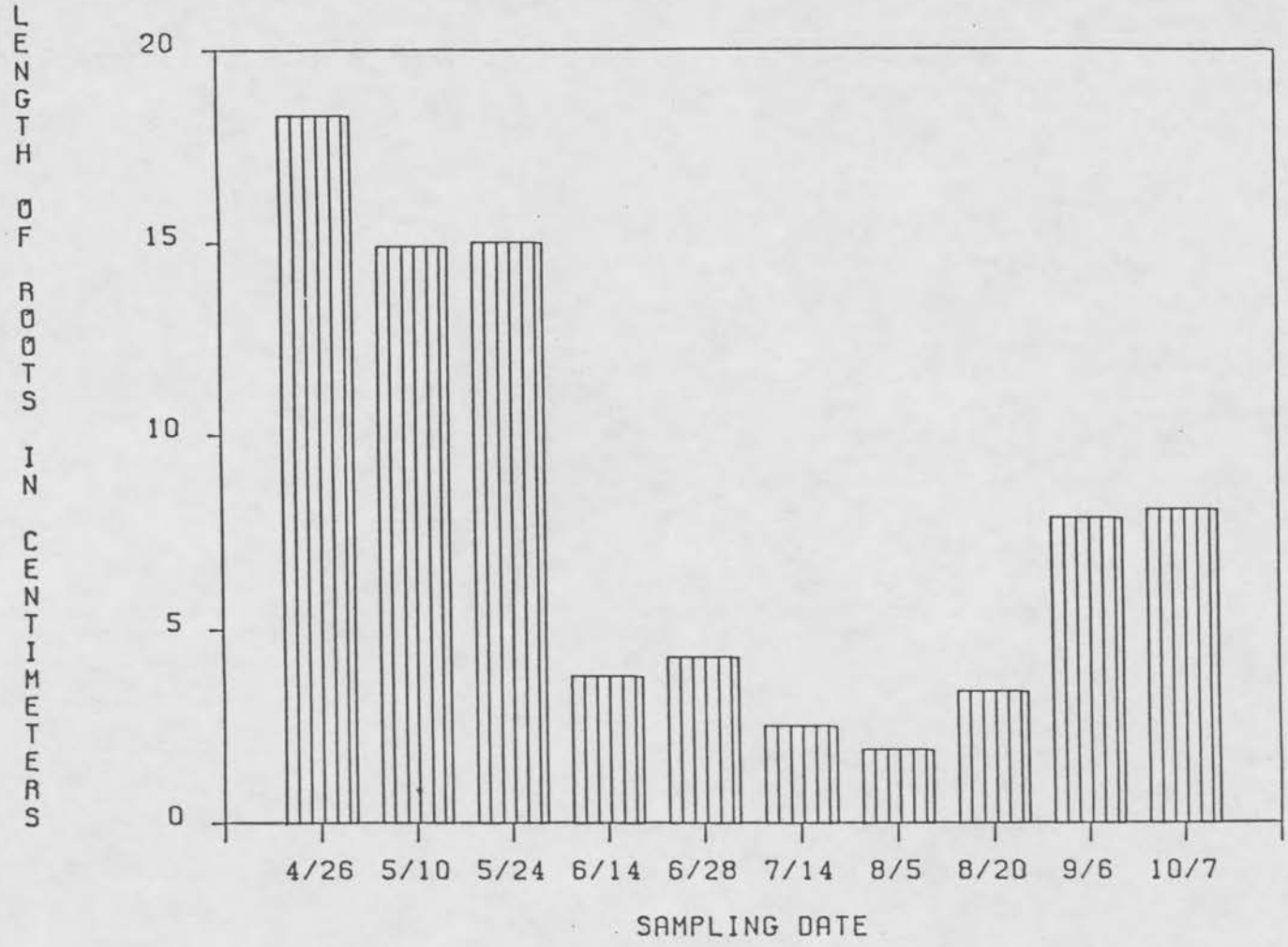
[1]All values represent the mean of 3 replications. Means are those of plants treated at 109 - 113 F.

Figure 6. Mean quality ratings of annual bluegrass on 9 dates in 1985.[1]



[1]All values represent the mean of 3 replications.

Figure 7. Maximum depth of the annual bluegrass root system on ten sampling dates in 1985.[1]



[1]All vaules represent the mean of 3 samples.

SEEDING ZOYSIAGRASS FAIRWAYS

Michael T. Dozier

Many golf courses in the transition zone of the United States experience difficulty in maintaining a dominant fairway turfgrass species. Kentucky bluegrass thins rapidly and goes dormant in mid-summer without substantial irrigation. Bermudagrass, a warm-season turfgrass, has been extensively utilized but has had winter-kill problems in certain areas.

Zoysiagrass, a warm-season turfgrass, has demonstrated excellent qualities for the transition zone. The current methods for establishing "Meyer" zoysiagrass are by plugging, stolonizing, and various forms of strip sodding. These methods are either very expensive or slow to fill in.

In recent years, seed treatment methods of alkaline scarification and light treatment have produced substantial germination improvements, enabling "Korean Common" zoysiagrass (*Zoysia japonica* Steud.) to be successfully established from seed. However, because of the necessity of high temperature and moisture needed for adequate germination, seeding is not practical until early June. The onset of hot, dry weather at this critical time often results in poor establishment.

In 1984, research was conducted at Southern Illinois University and Jackson Country Club, Carbondale, Illinois, to determine if various covers placed over seeded zoysia in mid-April would provide for earlier establishment. Substantial moisture retention and higher temperatures resulted under a polyethylene cover (Table 1). This provided for increased germination and thus, a healthier, more vigorous plant going into the hot, dry summer.

In 1985, the golf course implemented this technique on nine fairways, representing 12 acres. Zoysiagrass seed was drop-seeded into a sod previously treated with glyphosate at 1 lb/A in mid-April following verticutting in two different directions. Siduron was applied for preemergence weed control. The covers were placed over the fairways and sealed with sod strips. Covers were removed after two weeks.

The overall result of such a large project was excellent. In most areas, an 80 percent turfgrass cover was obtained in 10 to 12 weeks (Table 2). Some variability existed in heavily matted and low-lying areas where dead vegetative material and standing water created germination barriers. The project was deemed a success by both members and management and the other nine holes are to be completed in the spring of 1986.

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Table 1. Tensiometer Readings in Centibars, Taken in Top Three Centimeters Under Various Covers in 1984[a]

Treatment	28 April	3 May	17 May
Polyethylene	5	5	5
Lustor Strips	5	5	12
Tobacco Netting	7	5	40
No Cover	5	5	25

[a]Low moisture indicated by higher readings.

Table 2. Seedling Establishment at 10 Weeks Under Various Covers, Seeded 26 April 1985

Cover	Seed treatment	Ground cover (percent)
Polyethlene (4 mil)	S & SL	80.0
DuPont Reemay[a]	S & SL	64.2
White Plastic (4 mil)	S & SL	60.8
No cover	S & SL	50.8
	LSD at .05 =	17.1

[a]Copyrighted trademark of the DuPont Corporation.

PLANT GROWTH RETARDANTS

J. E. Kaufman

Plant growth regulators have been tested and used with success along roadsides for over thirty years. However, many users have found unexpected results with turf growth regulators and are hesitant about using them further. This article addresses certain physiological processes of turfgrass growth and development that were obscured during the revolution of turfgrass science and management in the 1950's. Briefly, development of efficient mechanical mowers and fertilizers designed specifically for turfgrass resulted in a rapid improvement in the ease of maintaining aesthetic quality in large acreages of turf. Turfgrass research on the life-cycle of cool-season grasses, particularly on the seedhead of the reproductive phase, more or less ended at that time, as these processes could be rather easily obscured through mowing and other management practices.

For years researchers have said that mowing results in a series of developmental and physiological processes in the plant, such as synthesis of the growth hormone ethylene at the cut end of the leaf blades and subsequent stimulation of tiller development. It is belived that these processes currently associated with mowing are again altered when the practice of mowing is reduced or eliminated. It is further believed that these processes are important in describing a large part of the erratic turfgrass response to growth regulators, both in turfgrass quality alteration and in growth suppression.

Turfgrass quality reductions during chemical growth suppression can result from a myriad of factors. Certainly, chemical injury is one of them. Some regulators are quite safe on the turf sward while others are very difficult to apply without injury. Consult the label directions to determine the relative safety of each product. However, the turfgrass quality issues emphasized in this article are those that appear at certain times with all regulators and are a result of natural leaf aging, senescence, and death.

Growth regulators work; some work differently than others. Achieving consistent, uniform results is easy when the right product is applied correctly in the proper situation. This article will also examine basic application techniques and will compare some basic technical properties of current commercial and experimental growth regulators so that the successful use of each can be optimized.

WHY USE GROWTH REGULATORS

Turf managers who have used growth regulators successfully indicate that growth regulators help them gain control over their operation in the spring

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when: all the consumers have spring fever; the boss wants all the spring clean-up work and all the new projects done right now; the crew is short because the summer students are still in school; the grass grows fast; and when you can't get out to work half the time because it's raining. Most managers agree that growth regulators do not replace mowing but can be used successfully to regulate mowing and thus provide for more uniform seasonal mowing practices. The most effective method of determining where to use a growth regulator is to identify the acres of turf that: (1) need to be mowed on a frequent basis; (2) are slightly away from the "showcase" areas that build the image of the operation; and (3) for one reason or another are difficult to get mowed each spring on a timely basis.

TIMING THE APPLICATION

Plant growth regulators (PGR's) for turfgrasses have usually been recommended for application at specific times of the year. Spring is the most common time because cool-season grasses exhibit up to 50 percent of their total, annual, vertical growth during a six-week period that usually begins sometime in April and ends sometime in June. Naturally, the preferred time to apply a growth suppressing chemical is just prior to the peak growth period.

In the summer, PGR's are not widely recommended for use because warmer temperatures have already slowed growth and little benefit can be derived from further reducing mowing frequency. In addition, summer is usually the period of highest traffic on turf and growth regulators have been shown to slow recuperation from wear stresses.

The fall represents an alternative application period to spring. Because of the short days and cool temperatures in the fall, cool-season grasses grow horizontally in preference to vertically. Much of the growth results in tiller and rhizome development. Thus, mowing frequency in the fall is not as great as in the spring, and the need for a growth suppressor may not be as great. Further, the horizontal growth habit of the plant is important for improving density of thin turfs, and PGR's may slow that development.

The method for describing proper spring application timing for most PGR's usually centers around green-up or spring growth. Terms often used include "full green-up," "100 percent green-up," "initiation of active growth," "commencement of vertical growth," and/or "first need to mow." However, these descriptions do not identify the other stages of development or the consequences of PGR application at those other times.

It is proposed that descriptive stages of spring development be identified to provide for better markers of proper application timing of PGR's. Research and observations at Monsanto have led to conclusions presented in this article indicating that the response of grasses to PGR's can vary from excellent growth suppression with little or no turf quality loss to poor growth suppression with severe turf quality loss.

STAGES OF SPRING GROWTH

Figure 1 outlines the annual life-cycle of cool-season grasses and identifies proposed growth stages: (I) cold dormancy; (II) green-up; (III) rapid vertical

growth; (IV) reproductive physiology; (V) revegetation; (VI) heat and drought dormancy, and (VII) fall revegetation. Since spring is the preferred time for application, only the first five stages are discussed in this article.

STAGE I: DORMANCY OR PRE-GREEN-UP

Pre-green-up is the appearance of the turf immediately following loss of snow cover. The appearance varies according to the kind of grass, the quality (color) of the turf the previous fall, and the severity of winter effects. Within days after the snow melts and under full sun, existing leaves that were not excessively damaged from winter effects will green-up through chlorophyll synthesis. Leaves damaged beyond repair remain brown and fully visible until warmer temperatures hasten their degradation.

In certain areas along the west coast and the mid-Atlantic east coast, winter temperatures are mild, and cool-season grasses only partially brown off. In this case, the pre-green-up stage does not occur.

STAGE II: GREEN-UP AND INITIAL GROWTH

As temperatures begin to warm, new leaves grow from the crown apex (growing point) within existing leaves. Older leaves degrade and are replaced by new leaves. This process, known as green-up, may occur over a period of several weeks, depending on how fast soil temperatures rise.

Late fall or early spring nitrogen applications promote grass growth and hasten the green-up process. The initial growth of spring-fall disease organisms, such as leafspot, begins at this time although infections usually do not appear on the leaves.

If this stage is prolonged by continued cool temperatures, the turf may reach 100 percent green-up while achieving only minimal vertical growth. During such a prolonged period, excessively high levels of disease populations can develop, and subsequent leaf damage can begin. High amounts of rain and high relative humidity may further encourage disease development.

STAGE III: RAPID VERTICAL GROWTH

The beginning of Stage III is most easily characterized by the need to mow. The grass is beginning to grow so fast that weekly mowings often remove much more than the recommended 1/3 to 1/2 of the existing leaf height. If spring season temperatures warm rapidly and consistently, this stage can be entered before 100 percent green-up, and more than one mowing may be required before complete green-up has been achieved. At the onset of this stage, development of spring-fall diseases is greatly reduced by warm temperatures, but some leaf symptoms may still develop. Rapid turfgrass growth makes the disease symptoms.

Near the end of this stage, the seedhead forms at the stem apex. The developing seedhead can be felt as a bulge at the base of the leaves. A number of plants need to be examined since not all will develop a seedhead each year. For verification, the leaves can be stripped, exposing a young seedhead, approximately

1/8 inch in diameter and 1/2 inch long. Stage III ends when the first, young, short seedheads, a high number of later forming seedheads can still be controlled. The duration of Stage III appears to vary according to the climate and weather but usually lasts 2 to 3 weeks.

STAGE IV: REPRODUCTIVE PHYSIOLOGY

In this stage, the seedstalk below the seedhead has begun to elongate. In many cool-season grass species, about the time the seedhead becomes visible in a mowed turf, a natural plant hormone (signal) causes the leaves on the tiller that bears the seedstalk to stop growing and provide nutrients and energy to the developing seedstalk. Thus the plant is under the effect of a natural, internal plant growth inhibitor.

At this time a signal (perhaps the same one) causes the lateral buds to start developing into tillers at a faster rate and to form a new crown apex. The aging leaves associated with the seedstalk discolor, senesce, and die as the young tillers grow and expand.

STAGE V: REVEGETATION

The turfgrass sward eventually replaces all the original plants through rapid growth of new tillers. The dead plants degrade and fall into the thatch. Thus, the green color of the lawn is maintained through development of new crown apices and new leaves.

LIFE-CYCLE VARIATION AMONG SPECIES AND VARIETIES

Normally this transition (life-cycle) occurs in a lawn with minimal disruption of turfgrass quality. Grass varieties or species that have difficulty maintaining quality during transition are referred to as the "stemmy" types.

In the cool-season region, May and June are known as the stemmy months for the stemmy varieties. Turfgrass researchers have known that the grasses are not attractive during the stemmy phase, and many turf managers have also recognized that certain varieties have stemmy characteristics in May or June. However, while stemmyness seems to be well known, it has not been well researched.

For many years turfgrass researchers have suggested that the key improvement of the Kentucky bluegrass varieties is improved resistance to *Dreschslera (Helminthosporium)* leaf spot diseases. Leaf infections in the spring are thought to translate into the severe "melting-out" turf losses that become most evident in the common varieties.

However, university researchers and turfgrass seed company researchers have also known that one of the major differences between improved and common Kentucky bluegrass varieties is the ability to produce seed. Common varieties produce copious amounts of seed and many of the improved varieties are very poor seed producers. As an example, the variety Sodco was very attractive in the vegetative state in the lawn, but failed to produce enough seeds for marketing. It is proposed that the severe turfgrass quality losses from the melting-out phase in

common Kentucky bluegrass are primarily a result of reproductive senescence of the leaves associated with the seedstalk and the leaf spot organisms that invade an already weakened plant.

Variation among species and varieties living through reproductive transition, in relative ease or difficulty, appears to be associated with two factors: (1) the overall tendency of the species or variety to produce seedheads (its percentage of the plant apices with potential to flower) and (2) the tendency of those plants to follow through with the flowering physiological state in spite of the mowing regimes imposed on them (seedheads regularly mowed off).

It is recognized that the more recently developed varieties, such as Baron, are both "improved" and have excellent seed production. It is suggested that the mowing regimes are quite effective in preventing these varieties from going through the destructive flowering physiology state.

As a cool-season species, tall fescue is best adapted to the transition zone of the United States, largely due to summer survival. Yet, unmowed tall fescue develops a seedhead, matures, and browns off while mowed tall fescue remains green. It is suggested that a major contribution to summer "tolerance" of tall fescue is the fact that frequent mowing removes the seedhead before natural hormones kill the leaves and a portion of the roots.

CHARACTERIZING THE GROWTH·REGULATORS

Growth is often defined as irreversible enlargement in size while development is the transformation of apparently identical cells into diversified cells and plant organs. Based on these definitions, the current turf growth regulators can be divided into two types. Type I regulators are those that effect both growth and development (Figure 2). Development not only includes the transformations from a seed to a mature plant in an annual species, but also includes the stages of the annual life-cycle within a perennial plant as shown in Figure 1.

Within the Type I group, Amidochlor, the proposed common name for Limit, is a suppressor while the others are usually labeled inhibitors. The inhibitors usually stop growth immediately after application while the suppressors allow for some growth. This may be partially due to their mechanism of action. Regardless, the end result is a gradual reduction of growth that eventually approaches inhibition. The concept of a suppressor is not to stop growth and mowing but to permit slow replenishment of turfgrass leaf tissue and to utilize trim mowings as needed.

Other chemicals known to inhibit growth and development of cool-season grasses are shown in Figure 3. These are defined as the herbicide type because all have a primary use as a herbicide. The herbicide types are characterized as having a very narrow margin of safety on cool-season grasses, and accidental overdoses can quickly and easily kill turf. However, the sulfonyl ureas will most likely find use along roadsides as a grass growth inhibitor, but the primary benefit is long term broadleaf weed control.

Type II turf growth regulators are those that only suppress growth (Figure 4). The developmental sequence of the plant continues; however, new plant organs

develop in minature size. Examples of this type include paclobutrazol, or PP-333, and flurprimidol, also known as EL-500 or Cutless. These compounds are often referred to as the "anti-gibberellins" and are effective internode elongation suppressors.

LIFE-CYCLE RESPONSES TO THE REGULATORS

If a Type I PGR is applied at Stage I, the most noticeable effect is a delay in spring green-up. Since development is slowed as well as growth, the rate of appearance of new green leaves is slowed and the size of the leaves is diminished. Root active growth regulators are effective in reducing growth when applied at this stage, while foliarly active compounds require green leaves to absorb the product.

For the root active product, research has shown that applications made in Stage II, from 70 to 100 percent green-up, have not shown excessive delay in green-up, especially where a fertilizer application was made at the same time. Applications at this time often result in slightly longer vegetative growth control compared to the 5 to 6 weeks normally found at optimum timing. Seedhead control levels may be less than optimum when applications are made this early but usually remain at an acceptable level of 80 percent or higher.

As discussed previously, development of spring-fall diseases is more noticeable when grasses are growing slowly, and further growth suppression with all PGR's during Stages I and II can result in increased visibility of disease symptoms. The following has been helpful in avoiding disease problems: (1) apply PGR's during Stage III where higher temperatures reduce disease development; (2) avoid applications to areas where common Kentucky bluegrass is under intense management; (3) avoid applications to areas having a history of spring disease problems; and (4) use the products on areas other than the "showcase" turfs, where diseases cannot be tolerated.

Stage III is considered the optimum time for application of Type I PGR's to provide good turfgrass quality and the normal 5 to 6 week duration of vegetative suppression or inhibition. Often, there is a slight loss of turf quality from the second to the fourth week and enhanced dark green color from the seventh to the tenth week or longer. Seedhead control is usually greater than 90 percent for applications made during this stage.

Rapid, vertical, vegetative growth signals the beginning of Stage III. Seedhead elongation signals the end of the stage, which is the latest application time for optimum results. As soon as the first seedhead is visible above the boot leaf, the application time is over, especially if a root-absorbed product cannot be watered in immediately after application.

Applications of any Type I growth regulator at Stage IV can be detrimental to the appearance of the turfgrass area, especially if the grass is a stemmy type. Growth regulators do not reverse the effects of the hormonal signal and, in effect, work cooperatively with the signal to completely inhibit growth of existing leaves. Likewise, they do not reverse the signal for tiller initiation, but they do greatly slow tiller development, at least for a time. Eventually one or more lateral buds, deep in the thatch and not having sufficient product, receive the signal. When that occurs, these buds rapidly grow and develop into tillers.

Thus, application of Type I PGR's at Stage IV result in undesirable turfgrass responses: (1) excessive growth inhibition for a short period; (2) severe loss of turfgrass quality as leaves senesce and die; and (3) early termination of activity due to rapid growth of escaped tillers not affected by the product.

TURF QUALITY ENHANCEMENTS RESULTING FROM PROPER TYPE I USE

The significance of this signal reinforces the fact that Stage III is the preferred time for the application. Since developmental inhibitors applied during Stage III prevent seedheads from developing, they also prevent the signal from being sent and prevent the negative turfgrass quality consequences of the signal. Therefore, these PGR applications can actually result in improved turfgrass quality compared with a nontreated area undergoing the "stemmy," reproductive, physiology phase. Further, the effect of preserving leaves seems to be accompanied by a preservation of existing roots. As a result, observations of improved summer growth, color, rooting, and tolerance to summer stresses, including heat, drought, and diseases, have been observed when using some Type I growth regulators.

WHAT ABOUT TYPE II REGULATORS

Because Type II plant growth regulators do not suppress plant development, applications at any of the stages from I through IV can result in (1) diminutive seedhead expression below the mowing height, (2) senescence and death of the main tiller, and (3) suppression of the size of the new tillers that normally grow large and mask the dying leaves. Therefore, no stage of application on stemmy varieties in the spring is acceptable for Type II plant growth regulators.

It is important to state that the Type II regulators do show acceptable results on non-stemmy, highly vegetative species and varieties. For instance, tall fescue seedheads apparently can quite easily be mowed off prior to the signal, even when stunted by a Type II regulator, and good results have been achieved. Type II growth regulator use on Baron Kentucky bluegrass, however, has not been as successful. Apparently, stunting the seedhead height does not permit the mower to remove the seedhead soon enough to prevent the natural signal and the leaves usually senesce and brown off rapidly during Stage IV. Finally, it should also be noted that Type II growth regulators have shown excellent performance in the fall season when perennial species do not exhibit the reproductive growth stage.

ROOT VERSUS FOLIAR ABSORPTION

Just as it is important to know where a pest lives in the turfgrass biosphere for targeting the pesticide application, the site of uptake of turf growth regulators needs to be identified and the growth regulator properly targeted to that site. The characterization of growth regulators in Figure 5 of soil versus foliar targeting indicates the optimum site of uptake for optimum activity.

For Limit, PP-333, and Cutless, the products must be targeted to the root system of the plant. This does not mean the products are not absorbed by the leaves. In fact, leaf absorption may reduce product performance. Once inside the leaves, downward movement is not possible. Thus, the only way for a chemical to

reach the basal growing points of cool-season grasses is through root absorption and upward translocation. In the case of Limit, targeting must be done as soon as possible because it is highly biodegradable with a half-life of one week or less.

For Embark, MH-30, and Maintain, the products must be carefully directed to the foliage. Uniform and complete leaf coverage is important for uniform response from these products. All of these products require a period of time on the leaves for absorption before rainfall occurs or the products can be inactivated. This is especially true for maleic hydrazide, which is slowly absorbed over a period of 24 hours. In addition, high humidities during the twenty-four hours are preferred for enhancing the absorption.

On the other hand, root absorbed products are "weather-proof," in that immediate rainfall hastens and enhances activity. Given the frequency of rain in April, when application should occur over much of the midwestern and northeastern United States, the probability of natural rainfall soon after application is high, especially if the applicator merely avoids the first sunny day after a rainy spell. Many turf managers are applying root active products during the rain, thereby taking advantage of an otherwise "down" day.

Further, research has shown that root absorbed growth regulators have not shown direct chemical burn on turfgrass leaves and may be overlapped without noticeable injury. In other words, any color loss due to improper application timing is not appreciably greater where overlaps occur. However, while overlap activity levels of Type I growth regulators are relatively similar to levels at the recommended rate, overlap activity of Type II growth regulators results in double the amount and length of activity. This results in uneven regulation of growth. Therefore, wherever growth regulator application has a high probability of resulting in overlaps, obvious ease of application advantages exists for root-absorbed Type I growth regulators.

The herbicide, fungicide, and insecticide information in Figure 5 is given to show biosphere targeting similarities, only. For example, from a targeting point of view, it makes good sense to tank-mix pre-emergence herbicides with root-absorbed growth regulators. Both can and should be applied in a rain. On the other hand, post-emergence herbicides that are tank-mixed with root-active growth regulators should be applied at least one day before any anticipated rain. Always read label directions regarding compatibilities before mixing any chemicals.

EQUIPMENT FOR PROPER TARGETING

It is important to first understand that any equipment designed for uniform coverage can be used effectively for most products. However, certain equipment for soil targeted products is becoming more widely used because of increased flexibility in application.

Figure 6 shows that for foliar targeted products, finer droplet sizes, higher operating pressures and lower carrier volumes are achieved with flat fan nozzles, usually mounted at predetermined intervals on a boom sprayer. The objective is to uniformly apply the product to each leaf while minimizing runoff. This same objective can be met with ultra-low volume micro-drop units or with mist blowers. The latter two pieces of equipment result in a great potential for drift of airborne particles. Foliar targeting equipment works well for root absorbed products since the next rain is the final carrier to the intended product destination.

However, the turf manager is increasingly utilizing single or multiple, large, flood jet nozzles or rain drop nozzles that provide larger droplet sizes at lower operating pressures. These systems usually require higher carrier volumes. The objective is to provide uniform soil coverage while minimizing the amount of product remaining available for leaf absorption. This objective can also be met with the ChemLawn gun or hose end sprayer, providing the operator is well trained.

For turf managers that desire to apply liquid forms of nitrogen, this targeting objective is of critical importance for minimizing leaf burn potential. Increasingly, turf managers are finding that these targeting objectives are also improving performance of soil active products that otherwise may be absorbed by the turfgrass leaves.

However, the key reason for choosing flood jet nozzles seems to be associated with the possibilities for the lateral projection of the product. High carrier volumes with large particle sizes can be projected laterally up to 15 feet on either side of a single flood jet nozzle. Lateral projection means improved equipment maneuverability among obstacles and easier application under fences. The single nozzle is not subject to the variation of application rates and skips that are common in the undulating terrain being treated with a boom sprayer. It also is not as subject to the variation that occurs when one wheel of the sprayer drops in a hole.

This type of equipment can also be used for foliar-absorbed products. However, it should be remembered that just as some of the root-absorbed material may be partially absorbed by the leaves and rendered ineffective, this equipment will direct a portion of the foliarly absorbed product past the leaves to the soil, which could result in less than optimum activity. In addition, larger droplet sizes will result in reduced ability to uniformly coat each grass leaf blade with the product. This could become important with products such as contact fungicides. Therefore, it is recommended that the turfgrass manager have both equipment types available for proper chemical application.

SUMMARY

The first and foremost ingredient for success with turf growth regulators is to read and follow label directions for each product. However, a thorough understanding of the principles of growth and development of turfgrasses and how each product slows or stops grass growth and/or development becomes important in choosing the right product for the righ job. Test the various products that are available commercially and experimentally. Success with turf growth regulators consists of: (1) choosing the right areas for product use; (2) applying the products at the right time; (3) using the right equipment; (4) targeting the materials to the right biosphere; and (5) using the right product for the right job.

FIGURE 1

ANNUAL LIFE CYCLE OF
PERENNIAL COOL-SEASON TURFGRASSES

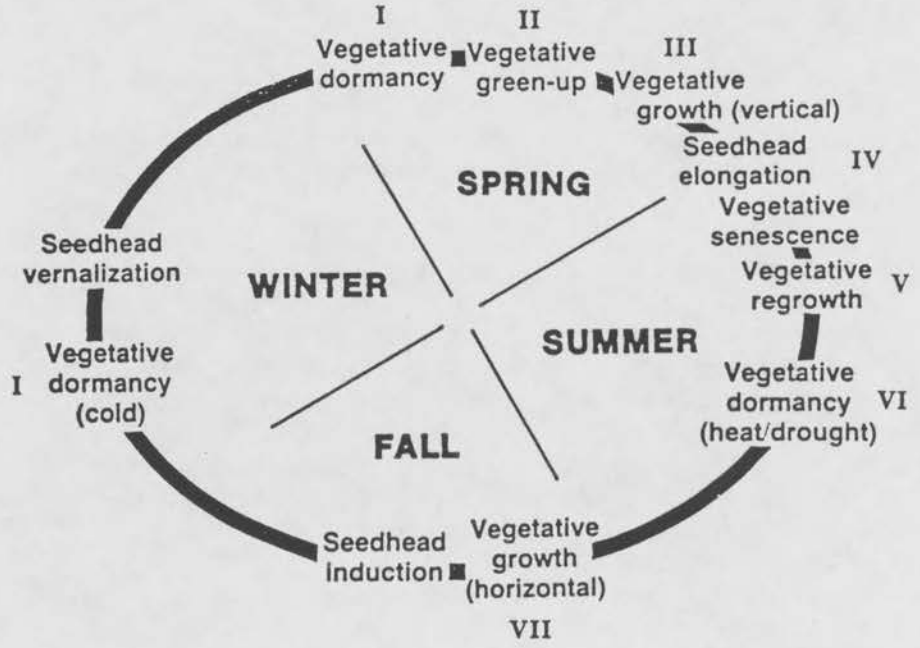

FIGURE 2

TYPE I GROWTH REGULATORS
Growth and development suppression (1)/inhibition (2,3,4)

1. **Amidochlor - Limit™**
2. **Mefluidide - Embark™**
3. **Chlorflurenol - Maintain CF-125™**
4. **Maleic hydrazide - MH-30™**

FIGURE 3

Herbicide TYPE I GROWTH REGULATORS
Growth and development inhibition/kill

1. Non-selective herbicides
   Example: Glyphosate - Roundup™
2. Selective broadleaf herbicides
   Examples: Sulfonyl ureas - Telar,™ Oust™
3. Selective narrowleaf herbicides
   Example: Sethoxydim - Poast™

FIGURE 4

TYPE II GROWTH REGULATORS
Growth suppression only

1. Paclobutrazol - PP-333
2. Flurprimidol - Cutless™

FIGURE 5

Type of material	Biosphere targeting	
	Soil	Foliage
PGR	Limit™	
PGR		Embark™
PGR		MH-30™
PGR		Maintain™
PGR	PP-333	
PGR	Cutless™	
Herbicides	Pre-	Post-
Fungicides	Systemic	Contact
Insecticides	Most	

FIGURE 6

SPRAY EQUIPMENT	
Soil	Foliage
Flood jet nozzle	Flat fan nozzle
Rain drop nozzle	Micro-drop ULV
Chemlawn gun	Mist Blower
Hose end sprayer	

RYEGRASS FOR ATHLETIC TURF

C. R. Skogley

The release of turf-type perennial ryegrasses has had a profound effect on athletic field quality. Only the development of the slicer-seeders, such as the Jacobsen and Olathe, has had as positive and significant an effect on improving athletic field quality as has the development of these remarkable grasses.

Anyone who has worked with athletic field maintenance will know that, for total success, the growing media (soil or sand) and drainage are critical and should be top priority. No matter how good our management practices are, or that we use the most adapted grasses, we can't be successful on poorly drained fields. The first priority, always, is to work to correct poor soil conditions and to assure good surface and internal drainage.

Regardless of soil and drainage conditions, most football and soccer fields and possibly other sports fields require annual renovation and the reestablishment of grass to portions of the field. In past years, the grasses primarily used were Kentucky bluegrass and tall fescue. Kentucky bluegrass has many attributes as a premier grass for the sports field in our part of the world. We should stick with it whenever we can. However, it has one serious shortcoming for use in renovations--slow seed germination and seedling growth. Very often, grounds managers have at best a two-or three-month period of growing weather to bring about a renovation. This really is not long enough to successfully establish Kentucky bluegrass. In those situtions where short term renovations are required, tall fescue has been recommended. When overseeded at a heavy rate, at least 12 pounds of seed for 1,000 square feet, the results were more favorable than with bluegrass. With the advent of turf-type ryegrasses, however, the recommendation has been quickly changed. Prior to the availability of slicer-seeders, renovations were harder to accomplish and not always fully successful. Difficulties were often encountered when trying to get the seed into the soil uniformly for good germination.

Studies on renovation at our research farm and also on nearby school and university athletic fields have shown that, in renovation where time is short, using only turf-type ryegrass provides the best results. A blend of three or four of the most adapted varieties for local conditions is recommended.

If renovations can be done in April or May and the field can be out of play until September, the use of a mixture of Kentuky bluegrass and ryegrass is recommended. Blending two or more varieties of each remains to be suggested. The seed mixture may consist of from 20 to 50 percent ryegrass, depending on the length of time available and the density and composition of the turf remaining on the field.

When overseeding with a slicer-seeder, criss-crossing from two or three directions will provide better results than when done in one direction only. The

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slicing is also doing a good job of aerifying. The blades should be set deep enough so that some soil is brought to the surface. Matting the field after seeding is a good practice.

Athletic field renovations are most frequently done from early to late spring. This is also a time when summer annual weeds such as knot weed and crabgrass are establishing. We have found it necessary to couple weed control treatments with renovations. Timing of herbicide application in relation to the seeding is very important, but effecive and safe procedures have been developed.

Turf-type perennial ryegrasses have provided the turfgrass manager with a marvelous tool for developing and maintaining better sports fields. They germinate and develop rapidly and can stand up to traffic as well as or better than other turfgrasses. These grasses have a pleasing appearance and their management requirements are not exacting. Additionally, they are versatile and widely adapted. If you aren't taking advantage of this relatively new development, you may be "missing the boat."

ATHLETIC TURFS: A NEW LOOK

H. L. Portz

Athletic areas are subjected to extreme wear and tear and soil compaction and are often played when wet or even during rainy periods. Rugby is perhaps the most damaging sport and players seem to enjoy the mud hole effect. Football is perhaps the second in wear intensity, and once fields are established, traffic patterns are concentrated within hash marks and between the 30-yard lines. Bands and other activities intensify the wear, compaction, and turf destruction. Soccer, although causing less divots, concentrates wear near the goal posts.

WEAR TOLERANCE OF TURFGRASSES

Machines have been fabricated to simulate wear and compaction but none truly match that of actual players. Most turfgrass species have been tested in various ways for their wear tolerance. The general concensus for cool season turfgrasses ranks them as follows (most wear tolerant to least):

1. Tall Fescue
2. Perennial Ryegrass
3. Kentucky Bluegrass
4. Red Fescue
5. Bentgrass

For warm season turfgrasses they are ranked as:

1. Zoysiagrass
2. Bermudagrass
3. Bahiagrass
4. St. Augustinegrass
5. Carpetgrass

One should note, however, that immature tall fescue stands are not as tolerant as the fast-growing ryegrasses and that sod-forming turfgrasses such as Kentucky bluegrass have better healing qualities.

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One wear-tolerant zoysiagrass has been used in Korea, where it is native, for baseball diamonds and soccer fields and will be used for the 1988 Olympic games. Comparing recovery from wear, bermudagrass is better than zoysiagrass, but a limiting factor in its use in the transition zone is frequent winter-kill. Both species go dormant in late fall; a colorant or overseeding is needed to finish out the football season.

Tall fescue has been used on many football fields and other athletic areas throughout the transition zone. Since it is a bunch grass, however, loss in stand and a bunchy turf result in an uneven playing surface. Combinations of Kentucky bluegrass and perennial ryegrass are very common and are often seeded with tall fescue.

COMBINATIONS OF TALL FESCUE AND ZOYSIAGRASS

The two best wear-tolerant species can be noted in separate lawns in Carbondale--so why not together for better wear tolerance as well as good late fall color. In June, 1975, "Ky-31" tall fescue was seeded after "Meyer" zoysiagrass was stolonized. A good stand of both continued in 1977 and 1978. In 1981, several cool season grasses and zoysiagrass, "Korean Common," were seeded at both Southern Illinois University at Carbondale (SIU-C) and at the United States Department of Agriculture's Research Center at Beltsville (USDA-B). Results at USDA-B are shown in Table 1.

Results at SIU-C were similar, showing good ground cover by early fall with rates of only 2 pounds or less of tall fescue and only 0.5 pounds of ryegrass needed to obtain over 50 percent zoysiagrass in the mixture.

By fall, 1984, there were excellent stands of both tall fescue and zoysiagrass in Beltsville and in spring, 1985, in Carbondale (Table 2).

ESTABLISHING TALL FESCUE AND ZOYSIAGRASS

The procedures for preparing the site and establishing the tall fescue and zoysiagrass on Carbondale High School's Bleyer Field were:

1. Killing the existing vegetation with glyphosate at the rate of 2 lb a.i./A in late April.

2. Rototilling the entire field with an asphalt ripper.

3. Grading to reestablish a crown for surface drainage (only enough soil for a 14-inch crown rather than a more desirable 18-inch crown).

4. Disking to break up lumps and compaction.

5. Fertilizing with NPK based on soil tests; the pH was adequate.

6. Harrowing to complete seedbed preparation. The experimental design and plot layout are shown in Figure 1.

7. Seeding of the "Korean Common" zoysiagrass with a Brillion seeder dropping about 1/3 pound of seed on the first pass.

8. Drop-seeding four tall fescue cultivars across the field using the yard markers for different cultivars and the two seeding rates.

9. Seed covering, leveling, and light compaction with two additional passes of the Brillion seeder that included the additional 2/3 pound of zoysiagrass.

10. Applying a preemergence herbicide, siduron (Tupersan) at 6 pounds a.i./A.

11. Continuing irrigation throughout the summer.

RESULTS AND FOLLOWUP

A good initial stand of tall fescue was noted and rated in 4 weeks (see Table 3). Seeding counts were taken in 8 weeks.

The followup included:

1. Mowing at 1 1/4 to 1 1/2 inches throughout the summer and then 2 to 2 1/2 inches during football season.

2. Nitrogen and phosphorus were applied in June and nitrogen again in July, August, and October. Additional potassium was applied in mid-October.

3. Bentazon (Basagran) was applied (2 X) in July to control yellow nutsedge.

4. The total field was aerified September 30 (2 X) and overseeded with annual ryegrass.

Wear tolerance ratings and stand density counts were made after the last football game and indicated a reduction in stand, especially between the 30 yard lines and within the hash marks where stand counts were taken. Figure 2 indicates stand density of the four tall fescue cultivars and zoysiagrass from June through October. By mid-August "Mustang" had the greatest stand density but dropped in October. This cultivar was in the heavy wear areas (near the 30-yard lines) in all replications so was probably unfairly treated compared to Ky-31. This shows in Table 4 where it is the lowest for player wear. Except for considerable goosegrass clumps, the field maintained good color up to late October.

CONCLUSIONS

1. Tall fescue and zoysiagrass can be successfully established together as a mixture.

2. Percent cover and stand are over 80 percent by football season initiation.

3. Rapid decline in stand and visible wear are noted between hash marks and the 30-yard lines due to football play and band marching activities by mid-October.

4. Careful spring management and summer care will be needed to reestablish worn areas by next football season.

5. It is highly recommended that a system of complete abstinance be exercised in the initial year of establishment *or* that a tall fescue/zoysiagrass sod be produced off site. It can be transferred to the field after 1 1/2 to 2 year's growth.

Table 1. Seeding Rates of Zoysiagrass and Cool Season Grasses and Resulting Ground Cover at USDA-Beltsville in 1981*

Cool season turfgrasses	Seeding rate 1,000 ft^{-2} (lb)	Seeding rate m^{-2} (g)	Ground cover in 7 1/2 weeks Total	Ground cover in 7 1/2 weeks Zoysiagrass**
			----------percent----------	
Perennial ryegrass "Citation"	0.5	2.5	77.2 b***	58.9 a
	1.0	5.0	94.5 a	33.3 b
	2.0	10.0	92.2 a	24.4 b
Kentucky bluegrass "S.D. Common"	0.25	1.75	68.3 b	80.6 a
	0.5	2.5	86.4 a	74.4 a
	1.0	5.0	58.8 a	60.0 b
Tall fescue "Rebel"	1.0	5.0	80.0 b	62.1 a
	2.0	10.0	85.5 ab	52.8 b
	4.0	20.0	88.3 a	48.3 b

*Scarified and light-treated 'Korean Common' zoysiagrass was seeded at 0.5, 1.0, and 1.5 lb 1,000 ft^{-2} (2.5, 5.0, and 7.5 g m^{-2}).
**Average of three seeding rates; represents percent of total ground cover.
***Means within columns of each species followed by the same letter are not significantly different at the 5 percent level of probability as determined by Duncan's Multiple Range Test.

Table 2. Species Composition of a Three- to Four-Year-Old Stand of Zoysiagrass and Tall Fescue[a]

Seeding rate (tall fescue) 1,000 ft^{-2} (lb)	Seeding rate (tall fescue) m^{-2} (g)	Species composition total stand	Species composition zoysiagrass
		---------percent---------	
	USDA-Beltsville, Fall, 1984		
2	10	100	55
4	20	100	50
	SIU-Carbondale Spring, 1985		
2	10	100	75

[a]H. Portz, SIU-C, and J. Murray, USDA-B, 1985.

Table 3. Percent Cover and Stand of Tall Fescue Cultivars and Zoysiagrass Seeded May 8 and 9 at the Carbondale Community High School Football Field

Tall fescue cultivar	Seeding rate 1,000 ft^{-2} (lb)	Seeding rate m^{-2} (g)	Cover, 4 weeks (%)	Ave. plant/tiller m^{-2}, 8 weeks (#)
Ky-31	1.5	7.5	33	1,074
	2.0	10.0	33	1,280
Rebel	1.5	7.5	21	1,028
	2.0	10.0	26	1,332
Mustang	1.5	7.5	23	1,666
	2.0	10.0	26	1,258
Falcon	1.5	7.5	21	1,112
	2.0	10.0	26	956
Zoysiagrass	1	5.0	no rating	123

Table 4. Visual Rating of Player Wear for Four Tall Fescue Cultivars and Zoysia Japonica Seeded on a Football Field After Games

Cultivars and species	Visual rating of wear†
Ky-31	3.5 a*
Falcon	2.8 b
Rebel	2.8 b
Mustang	2.6 b
Z. japonica	2.5 b

†Visual ratings based on 1-leaf injury and bare soil and 5=no injury.
*Values with the same letter are not significantly different at the 5 percent level, using LSD test. LSD=0.42.

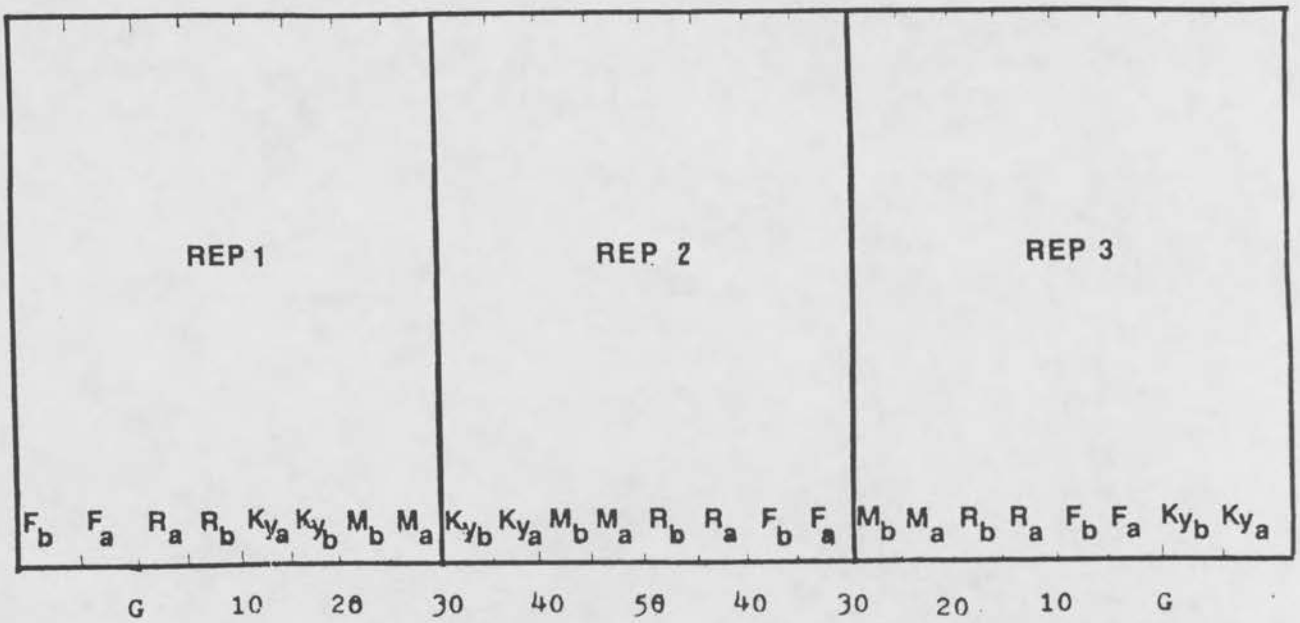
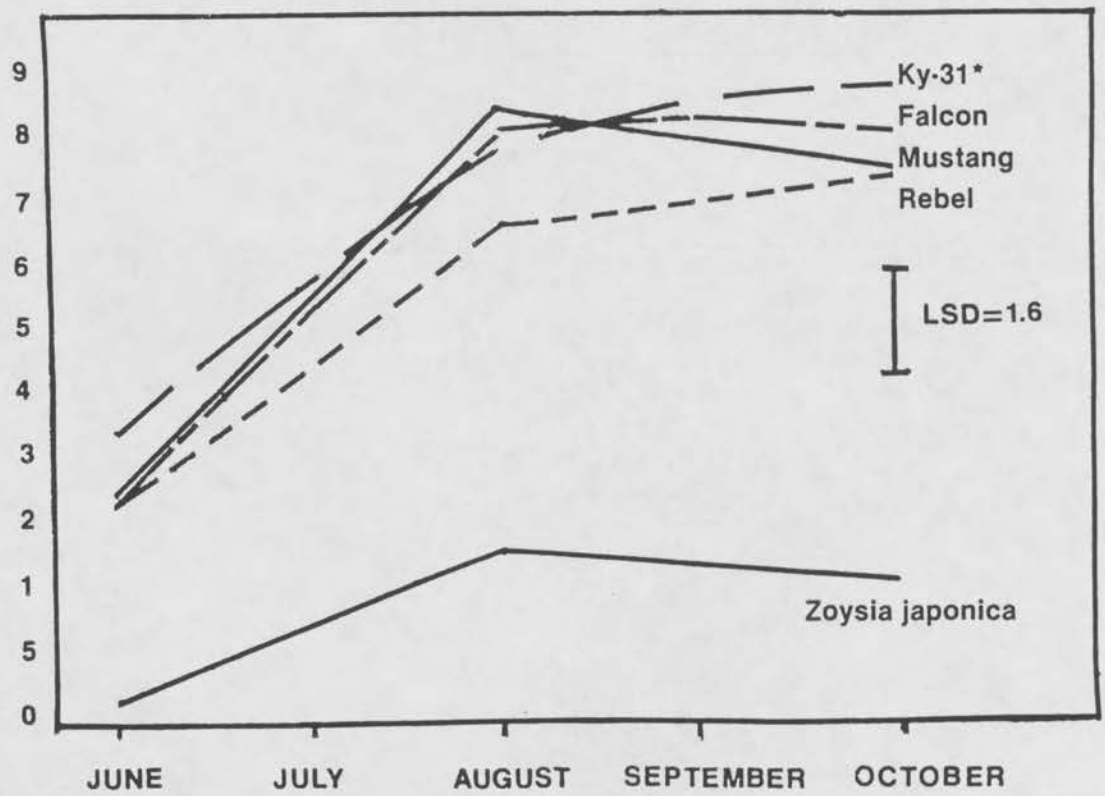


Figure 1. Experimental design and plot layout at CCHS. Experimental layout: split-plot design with randomized sub-plots. Tall fescue cultivars: Falcon, Rebel, Mustang, and KY-31. Seeding rate: 1.5 lb/1,000 ft^2 (a) and 2.0 lb/1,000 ft^2 (b). Zoysia japonica: seeded in all reps at 1.0 lb/1,000 ft^2. Sub-plot size: 15 by 160 feet.



**Means tested at 5 percent level using LSD.*

Figure 2. Stand density of four tall fescue cultivars and zoysiagrass seeded on a football field.

THE WONDERFUL WORLD OF SPORTS TURF

Kent W. Kurtz

The wonderful world of sports turf appears to be a glamour industry and business where superstars abound, celebrities flaunt around during the event, and everyone is rich and happy. When the bubble bursts and reality returns it is evident that the rich get richer, the poor get poorer, the strong get stronger and the weak get weaker. Today the large stadiums offset their high operating costs and overhead by sponsoring many and varied events on their playing fields. Events range from baseball, football, and soccer to the bizarre, such as tractor pulls, motocross, mud bogs, and rock concerts. When and if the turf wears out or is completely destroyed by the event, the old turf is pulled up and replaced with new sod. Money is no problem because these events produce excellent revenue and the profit motive almost always has top priority.

At the other end of the spectrum one observes the local school sports field or municipal park playing fields. These facilities are used more and more each year for longer periods of time. Lights are installed for night activities such as youth soccer, baseball, or softball. The use factor is double or triple that of previous years. As a result, the fields rarely get an adequate rest. Maintenance personnel are expected to perform miracles on these facilities with less money and man-power. The problem of over-use and abuse is beginning to catch up with many school and park administrators and boards. As the turf deteriorates and the soils become hard and compacted, the risk of serious injuries is intensified and the liability probability is enhanced.

Sporting events have been played on natural grass surfaces for many centuries because man sought a common ground that was free from mud, dust, water, rocks, and hard compacted soil on which to match his skills with those of his opponent.

Natural grass surfaces for sporting events are preferred by most participants throughout the world today. Although by no means complete, the following list of sports or games are played on natural grass:

badminton
baseball
bocce
cricket
croquet
field hockey
football
golf
horse racing
hurling
la crosse
lawn bowling
lawn tennis
polo
rugby
shinty
soccer
softball
track and field
volleyball

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Suddenly, in the early 1960's, man-made, artificial surfaces appeared out of nowhere and began making inroads into the sports turf world. This was over two decades ago; in some circles the popularity of artificial surfaces has "spread like wild fire." Artificial surfaces are evident on the professional level down through the college ranks and even where "big time" football is played in the high schools. The rationale for installing artificial turf on the high school level is that administrators want their players to experience the type of surface they will encounter in college or later on if they should become professionals.

Synthetic surfaces are developed, marketed and installed on the false pretense that maintenance will be minimal, costs will be reduced, the fiber will outwear and outlast natural grass and finally, that these "rugs" can be installed anywhere, even where natural grass will not grow. The "plastic revolution" has endured due to the power wielded by large corporations that have massive advertising budgets. The media and specifically television have created a lot of hype and made certain demands on many schools in return for dollars and national exposure. But probably the biggest reason artificial turf gained inroads into the sports turf market is due to the weakness and lack of sound technology and research on sports turf problems in the past. The primary universities where turf management is taught and researched were more intent on spending time and effort on the major agronomic and horticultural crops. During this period, serious dedication and investigation to improve sports turf soils and to develop a line of improved, wear-resistant grasses was almost non-existent. Most turfgrass scientists and investigators directed their major attention and effort toward the golf turf industry. The sad truth is that, even today, some twenty-five years later, most research efforts are devoted to improving golf turf and not sports turf. The golf turf industry is united in their efforts to raise money to support research, education, and the future of their industry.

Improvements in the sports turf profession through research and education have been virtually ignored by all groups involved in sports turf in the United States. Most countries have a sports turf authority which is responsible for and concerned with research and education. For instance, in England the Sports Turf Research Institute (STRI), located in Bingley, West Yorkshire, has a large staff of individuals who conduct educational conferences, seminars, and workshops and conduct numerous research projects which are funded by sports organizations, teams, governmental agencies, commercial affiliates, and private individuals. All amateur and professional sports organizations, schools, parks, and other related groups are affiliated members of STRI and support the total effort through donations, gifts, and grants.

Why then have the sports turf industry and sports related professions in the United States remained in the dark ages for so many years?

Many reasons can be directly related or attributed to the passive nature and attitudes observed in the sports turf profession. First, and foremost, there has been no unifying force, body, or organization on a national basis to direct or coordinate sports turf educational and research programs. Second, the average sports turf manager has kept his ideas and maintenance techniques a secret and has been unwilling to share his knowledge and experience with others. Typically, the sports turf manager has not been an "organization man" or "joiner" and has been content with the status quo by doing nothing to change his image from that of a janitor or caretaker to a professional. Third, the sports turf manager has

generally accepted, without question or argument, the myth that there are no funds available for maintenance and field improvement. He has never fought for safer sports turf and has spent minimal time and energy attending conferences, meetings, seminars, and trade shows to learn more about new ideas, concepts, methods, and procedures that could have great impact in improving his sports turf. Fourth, many sports turf managers lack formal training, knowledge, and the expertise required of them to perform their job adequately. However, until recently, there have been no comprehensive training programs, scholarships, or curricula available to train students in the management of sports turf. The fifth reason is quite complex and very tragic because it shows the overall lack of concern by today's society for the safety of our children and other competitors on the nation's sports fields; it appears that few people are concerned or interested in better quality and safer sports turf. Cited as reasons for this lack of concern and interest are (1) someone else should be responsible; (2) no time is available; (3) people don't understand what is needed; (4) money is not available, and finally; (5) sports turf has a very low priority in the system (schools, parks, public facilities).

Hopefully, the 1980's will be remembered as a renaissance period for natural grass playing surfaces. The Sports Turf Managers Association (STMA) became incorporated as a national organization and emerged as the leader and unifying force in the sports turf profession in 1985.[a] The goals and objectives of STMA are to improve the condition, quality, playability and safety of sports turf everywhere. By sponsoring educational conferences and trade shows both regionally and nationally, STMA hopes to educate and upgrade the sports turf manager in both the United States and Canada.

The formation of the National Sports Turf Council (NSTC) as a subsidiary of the Musser Foundation will also unify the sports turf industry.[b] The goals of NSTC are to make sports turf safer through research and education. National organizations such as STMA will be affiliated members, and companies along with interested individuals can be subscriber members.

Also in the 1980's, we may see a reduction in the use and installation of artificial surfaces. Severe injuries have accelerated on artificial turf and many careers have been prematurely terminated as a result of playing on these surfaces. In addition, resurfacing artificial fields is extremely costly (upwards of 1.0 million dollars) and the high cost of maintenance which exceeds that of natural grass by 3 to 4 times may be reason enough to once again consider natural grass sports fields. The majority of professional football players prefer natural grass over the artificial surface and many professional baseball players now have clauses in their contracts preventing them from being traded to a ball team which plays on synthetic turf.

Even though the sports turf industry has a long way to go before it catches up with the progress made by the golf course profession, technology is available, today, to design, construct, and manage environmentally controlled sports turf. It may not be very long before we see natural grass being grown inside the new domed stadiums. Soil warming, either by electric heat cables or buried steam pipes, is being used on some fields; excellent drainage systems are available.

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[a]STMA, 1458 North Euclid Avenue, Ontario, California 91764
[b]NSTC, P.O. Box AA, College Park, Maryland, 20740

Sand is being used more and more as soil media, chemicals, and fertilizers are being developed to be more selective, effective, and longer-lasting, and new improved turf-grasses are being developed which have superior qualities for sports turf use.

The world of sports turf is finally emerging and will be a powerful force to reckon with in the turf industry. A well-maintained, natural grass turf is a powerful factor in reducing injuries to athletes. Now is the time to join with fellow-professionals to bring professionalism and quality to the sports turf management industry.

ENVIRONMENTAL LEGISLATION

Dwight Dunbar

Environmental legislation is, in fact, difficult to characterize. During the past few years when I have been closely involved with the legislative process, I've seen "environmental legislation" come from environmental activists--a traditional source--as well as from business and industry--who traditionally want less government. The complexities of characterizing any legislation are magnified by the fact that a particular piece of legislation's main objective is not environmental (for example, building new roads and bridges has an environmental aspect). Depending upon your particular point of view, that may be the most significant aspect.

For the particular group I represent, the agricultural fertilizer and chemical industry, I try to limit the scope of environmental legislation to concerns for chemicals and their use, transportation, storage, waste handling, and disposal. These are by no means the only legislative areas of concern, however. By the same token, we do not make an issue of every piece of legislation that appears to fall within the parameters I just mentioned. Specific legislation which I, or anyone, in a similar capacity become active on is a matter of reviewing *all* and selecting a *few* as "my issues" and probably monitoring about half of those not selected for amendments that change the original intent or impact.

FEDERAL LEGISLATION

Let's look briefly at some of the environmental legislation at the national level in 1985. The Federal Insecticide Rodenticide Act (FIFRA) was up for reauthorization and expected to receive major amending. The FIFRA is the basic pesticide law of the land, you will remember. Also, "Harper's Ferry" amendments resurfaced, as expected. There has been much talk in Washington that "Harper's Ferry II" amendments would pass Congress with ease. However, with the "big issues" before Congress taking everyone's time and attention, even simple reauthorization kept being postponed. The most dramatic development was the announcement this fall that the pesticide industry and "Harper's Ferry" supporters had reached agreement in principle on the areas of FIFRA that needed changing and the direction in which the changes would take pesticide regulation. That agreement, however, has been difficult to turn into legislative language, and at this time, it seems likely 1986 will be the year for FIFRA amendments. It is likely that amended FIFRA will include more on water quality/pesticide use,public participation in registration, and registration review and certification standards, all of which will impact the end users in the pesticide industry.

Dwight Dunbar is Vice-President, Illinois Fertilizer and Chemical Association, Springfield, Illinois.

STATE LEGISLATION

1985 has been an interesting year for state environmental legislation. Since there seemed to be little, if any, upheavals as a result of the "Worker Right to Know" legislation passed the previous year, it seemed like a good idea to extend it into "Community Right to Know" legislation. In the form of House Bill 300 (H300), which was heavily lobbied and changed in many ways after introduction, "Community Right to Know" took shape. Much of the impact on end users of pesticides was removed through successful lobbying efforts. Ultimately, though, H300 was defeated on a third vote in the Senate.

Nonetheless, along these lines, some legislation was developed and ultimately passed the general assembly. Several bills emerged that were more appropriately tagged "chemical safety" legislation. By and large, these bills impact the chemical manufacturing, distribution and use system prior to end use formulations or end use activities (for example, application of pesticides). For the most part, the impacted industry is "up-to-speed" with requirements for "chemical safety" legislation. Their in-house and voluntary programs will now have to be formalized with the government being directly involved.

Water quality did not escape the attention of the Illinois General Assembly as an area ripe for legislation. However, their first steps were aimed at developing a better understanding of the problem (or problems) and possible solutions and to report back to the legislature in 1986. The creation of a "study of legislation" means that legislation will surely follow, but it usually provides some preview of what the legislation might include.

Finally, during the 1985 spring session, environmental legislation affecting pesticide end use surfaced on three fronts. A bill introduced in the Senate which would have required lawn posting--along the lines of the Wauconda Ordinance--and buffer zones in towns was short-lived. This bill was placed in a study committee and will technically die after all veto session activities are over--December 31, 1985, approximately. Another set of proposals came from the Health and Medicine Policy Research Group. Essentially, their stated objective was to provide adequate resources to insure the public is protected from toxic compounds. Their pesticide regulatory suggestions were based on a thorough review and evaluation of facts and dealt with the needs of regulatory programs *already in place*, not recommending a total overhaul of the system. Discussion with the group, agencies involved, bill sponsors and three or four active lobby groups of those most directly affected (often at my direction on behalf of our association) developed compromise bills which ultimately passed the general assembly and were signed by the governor. Major provisions of this package include increases in product registration fees and creation of a pesticide control fund. There were two, significant, positive aspects to this entire process. First, members of the general assembly looked to my association for direction. Second was the fact that, for the first time I can recall, environmental activists and industry sat at the same table and worked out compromises. The last area of pesticide (environmental) legislation was initiated by the Department of Agriculture to update the 1979 Pesticide Act as ordered by the general assembly oversight committee. They needed primarily technical changes. My association had recognized some short comings of that original act and discussed possible amendments with the department. As a result, I prepared the language that became part of the "Department's Bill" to resolve those concerns. The bill finally passed--S812--and included several additional definitions for the 1979 act. These will allow the department to establish

regulatory policies, rules, and regulations in some critical areas where they previously could not because the law was silent on those subjects.

I hope my comments to this point have given some insight into the diversity of "environmental legislation: and an understanding of areas which my association had made "our issues." By way of numbers and summary, I reviewed about 300 of the bills introduced this last session (not quite 10 percent of the total introductions), developed a watch list of over 80 bills, and ended up with a "to monitor" list of 39 bills. The 39 included only 8 or 9 bills not dealing with environmental issues. Monitoring, for me, includes following the bill closely, even if it is not "our issue", to "comment on it," and to lobby it, both formally and informally.

OUTLOOK

I believe we can look forward to further "chemical safety" legislation that may reach far enough to impact, in some way, those of us who are end users. The future direction of chemical safety will likely be more towards right to know issues and concerns. Water quality will begin to be *the premier environmental issue* and will retain that status for the next several years simply because it is such a complex issue. I also have to believe that, in spite of its clear rejection by the Senate, "Community Right to Know" is not completely dead. As for many of the narrower environmental areas, such as disposal and storage, they will be dealt with to some extent as water quality issues--especially ground water--to be resolved. Legislation dealing with some of these specific areas will surface periodically, but normally, they will be agency-initiated and, if history teaches, only after the Federal government takes or proposes action. Specifically, in the area of pesticides, rule making will be the order of business in the next year or so as far as the Department of Agriculture is concerned. My best indications are that major pesticide legislation is not expected to appear. From whatever source, further pesticide regulation in the near term will be a part of the chemicals/water quality legislative initiatives. This will bear close watching.

NOT NECESSARILY ENVIRONMENTAL

I want to add a final word that liability insurance is now surfacing as the "hottest" and most pressing concern for everyone, including the legislature. My association is participating in a broadly-based coalition whose objectives include bringing tort reform and changes in the law, relative to liability, so that the insurance industry can better define risks and therefore, know how to price their buying of a risk. Many aspects of the issue and the ways to deal with it are just now coming into focus. Next year, you should hear a lot more, and because every person is affected, I would hope that you become involved individually or as a group.

MARKETING THE GOLF COURSE

Lou Carter

Many golfers have experienced bad markings on a golf course. The usual occurence is hitting a good drive on relatively flat terrain that ends up in "the invisible creek," which was only marked by painted lines.

The U.S.G.A. recommends the following for marking a golf course: (1) Water Hazards--marked with yellow stakes or lines; (2) Lateral Water Hazards--marked with red stakes or lines; and (3) Out of Bounds--marked with large white stakes already established by walls or fence posts.

A well marked golf course will require few, if any, special rulings by the rules committee or the golf professional. However, the golf professional should work very closely with you while marking and staking is taking place. He should be reminded that he will be called upon to make most rulings and therefore he should know and understand how and why the course is marked in the manner it is.

There are basically two types of marking to be done: (1) sprayed lines, and (2) placement of stakes. When marking the course with spray paint, first determine the quantity of paint needed for each color to be used. One should also take inventory of existing paint supplies to provide an estimate of how much will be needed to do the job. Ordering paint can take 7 to 14 days, depending on the distance of the course to the paint distributor. Spraying is very important: a task several persons on the maintenance crew should know how to do. Lines that have become less visible due to mowing or rainfall should be replaced. Lines should be checked daily to make sure the course is always adequately marked. The most common mistakes noticed are the lines in "Grounds Under Repair." All hazards do not have to connect themselves to completely encircle an area. There are many instances in which a hazard may border a nonhazard area, and these two areas may need to be separated. When "Out of Bounds" lines are used, they should start and stop with out of bounds stakes for visibility.

When marking the course with stakes, one needs to determine the number and height of the stakes that will be used. The terrain can effect the total number of stakes needed. The distance between stakes is important, in that players should be able to sight easily from stake to stake to determine if their ball is inside the imaginary drawn line.

One should remember that approximately 5 to 10 percent of all stakes will break due to that hardness of the ground and the carelessness of golfers. In general, 10 percent can be used as a replacement percentage. In addition, one should remember that stakes, like spray paint, may need to be ordered, assembled, and allowed time to dry adequately.

Lou Carter is Head Golf Professional, Peoria Park District, Peoria Illinois.

PERSONNEL MANAGEMENT

John C. Potts

Ever since the beginning of time, societies have set standards of behavior for numbers of the community. As the society becomes more and more complex, the rules for behavior become more and more complex. Unfortunately, when the rules of behavior become so complex that the common man can no longer comprehend them, the society shatters and the survivors set up a new society based on simpler rules, and the whole process begins again. An outstanding example of this evolutionary process began with Moses delivering the Ten Commandments from the mountain. There has probably never been a more simple, straightforward set of rules ever conceived to regulate human behavior. Moses had no sooner delivered the message, however, when the process of definition began. The rule says, "Thou shalt not kill." What about self-defense? What about wars to defend our society? What about protecting our property? Over the centuries, the rules, definitions, and codes arising from the original Ten Commandments became so complex that they even stipulated the length of a piece of string that could be carried on the sabbath without raising the ire of God. The codification of these rules became so incomprehensible to the common man that their society was shattered by Jesus Christ's simple and reassuring rules of conduct.

I believe that the management of people to perform work follows a similar cycle from the simple to the complex and back to the simple again. I further believe that the time is ripe for us to shatter the complexities of our management procedures and return to a simpler and more reassuring management style. The following are examples of management "tools" that are becoming complex to the point of nonsense, which could be easily simplified.

EMPLOYEE POLICY MANUALS

Employee policy manuals are based on the simple and valid principle that employees like to know what is expected of them. It has been an accepted management practice for forty years or more to prepare such documents for the use of employees. What began as a simple and utilitarian idea has become a monstrosity in today's management circles. Managers and administrators feel obligated to try to predict every possible human behavior and every possible circumstance that could arise and deal with it in advance. I have on my desk a policy manual for a golf course in California that lays out the procedures for starters. It begins with "Open the door, turn on the lights" and goes on in that same vein for four full pages. Wouldn't it be much simpler for everyone involved to lay down a few general guidelines and deal with individual problems as they arise. Far too often, complex policy manuals become a crutch for managers who are not comfortable in dealing directly with people. One manager whom I know, in an attempt to write an all encompassing policy manual, kept repeating over and over again, "we have to treat everyone the same." To me, treating everyone the same is a poor substitute for taking the time and effort to listen to people, to understand them, and to deal with their problems on an individual basis. There's a wide gulf between treating people the same, which is inherently unfair, and treating them fairly.

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The more complex the codification of working procedures becomes, the less latitude the manager has in dealing fairly with individual cases. Employee policy manuals should contain broad concepts that allow both the manager and the employee the greatest freedom possible in accomplishing their work tasks.

EMPLOYEE EVALUATION FORMS

Today's evaluation forms are classic examples of over complication. Most evaluation forms list ten or twelve different characteristics of the employee and rating scales that often run from one to ten. Under the guise of being "objective" the forms attempt to reduce subjective human behavior to a series of numbers. As a result, employee evaluations become meaningless to both the manager and the employee. In the December issue of *Park Maintenance and Grounds Management* magazine, Lamar Logan, a Park Superintendent from Baton Rouge, Louisiana, offers a ray of hope. He states, "One is asked to evaluate people on qualities that their own mothers would hesitate to mention, such as use of common sense, sense of value, ability to learn, appearance, manners, sociability, and integrity. I doubt there is a person among us who would have the guts to evaluate someone honestly on those traits." He goes on to state that there should be only two ratings: (1) Satisfactory and (2) Outstanding. This is based on the belief that a satisfactory rating means that an employee is doing what he was hired to do and that an outstanding rating would be extremely hard to obtain and would indicate that the employee was doing far more than just his basic job. Logan argues that less than satisfactory performance cannot be dealt with on an annual basis but must be corrected immediately and on the spot. If an employee fails to correct unsatisfactory behavior, he should be placed on probation or dismissed. An employee evaluation form based on these criteria would be extremely simple and understandable. If it were combined with a short paragraph or two that outlines the employee's strengths and weaknesses, the employee evaluation could again become a useful tool of management.

BUDGETS

The advent of the line item, computerized budget is a mixed blessing to management. It is extremely useful for monitoring progress on a fairly regular basis. Far too often, however, managers look upon budgets as something cast in stone and forget that a budget is basically a plan of financial action. Plans must be flexible and must accommodate themselves to changing conditions if they are to be successful. Although most managers will accept the flexibility principle with other planning processes, financial data has a tendency to become inviolate gospel. Fiscal responsibility dictates that the bottom line of budgets be fairly accurate because we cannot spend more money than we have coming in, but focusing our attention too closely on individual line items does not allow adaptation to changing conditions and unforseen circumstances. Budgets must be a tool for managers to use and not become a major criteria to measure their performance.

WRITTEN COMMUNICATIONS

Written communications used to be just that: a means of communicating in writing. More and more, written materials are becoming primarily a form of documentation rather than a form of communication. If your supervisor sees a hazardous condition on the golf course and sends you a memorandum suggesting that you

repair it, he is not communicating, but is documenting the fact that he has transferred the responsibility for that condition from him to you. If communications were his first priority, he would have told you on the telephone or in person. In my experience, a very small portion of the mass of written material that crosses my desk is informational. The great majority of it involves documentation on the part of the writer that I was informed of some fact or another. Written communication is time consuming and is a poor substitute for face to face communication. There is a time and a place for documentation, but it would simplify all of our lives if managers were more concerned with communication and less concerned with covering their backsides.

STAFF MEETING

As a manager it is essential that staff meetings between the manager and the employees occur on a regular basis. I have already stated that I am a great believer in face to face communications. Managers err, however, when they attempt to use these meetings to form a consensus for action against a specific problem. Managers are paid to make decisions. Too often they ask their employees to share in their responsibility for these decisions through formal or informal staff meetings. Good managers use these meetings to gather the necessary information to make sound decisions. They make no attempt to reach a consensus of those involved in the meeting because they know that the final decision is their responsibility and theirs alone. To attempt to transfer that responsibility to other employees is an abdication of the job that the manager is paid to do. If you enter a meeting with that concept firmly in mind, you will find that there is much less wasted time and argument.

BENEFITS OF SIMPLIFICATION

What can be accomplished through the simplification of management tools? First, and most important, we can introduce more clarity and honesty in our dealings with our employees. I cannot help but believe that some modern managers use complex and confusing techniques to create a smokescreen behind which they can bob and weave. It may not be as comfortable to operate with our hands in plain sight, but it certainly contributes to a clearer understanding of the goals and objectives of the organization.

The second important benefit of simplification is that simple procedures take less time than complex, thus freeing the manager for his most important function--direct observation in the field. Managers who become fascinated with paper tend to become deskbound bureaucrats who quickly lose track of the people who deliver our services. Losing track of service delivery is managerial suicide.

CONCLUSION

Complex management procedures are too costly and inefficient to survive over a long period of time. When the system becomes so cumbersome that the employees can no longer comprehend it, the system shatters and the manager is usually a part of the fall-out. As is the case with a society, the survivors will rebuild a simpler, more satisfying system. The wise manager can avoid disaster by formulating simple, honest procedures allowing both leaders and followers the elbow room required to excell.

LAWN OVERSEEDING AND RENOVATING

Joseph M. Vargas, Jr.

The purpose for changing the components of the turf community must be determined before choosing whether to overseed or renovate. If the purpose is to introduce new cultivars into an existing Kentucky bluegrass turf for improving disease resistance, drought or wear tolerance, density, and the like, then the use of plant growth regulators to suppress the growth of the existing turf and overseeding will probably suffice. If the purpose of changing a turf is because of a perennial weedy grass problem like quackgrass, creeping bentgrass, or tall fescue, then it will be necessary to renovate the existing vegetation before seeding.

Overseeding an existing Kentucky bluegrass turf to introduce new cultivars with Kentucky bluegrass is impossible, unless something is done chemically to slow the growth or destroy the existing turf. This is probably due to the poor seedling vigor of the Kentucky bluegrasses. One solution is the use of plant growth regulators (PGR) like Embark. Overseeding can begin one week after the application of Embark. The turf should be cored in two directions with a greens coring machine or similar unit that makes holes on two-inch centers. The seed should then be broadcast over the lawn using a Rogers seeder or similar unit (in two directions if possible). Finally, the lawn should be dragged several times with a suitable mat to work as much seed as possible into the coring holes. This process may have to be repeated every fall for two or three years to finally establish a large percentage of new Kentucky bluegrass cultivars in the lawn.

The other option is to use perennial ryegrass that has a vigorous seedling stage and will become established in an existing Kentucky bluegrass turf. The seeding procedure described in the preceeding paragraph should be used for fast establishment of perennial ryegrass turf, the only difference being that PGR will not be required. This is not an endorsement of the perennial ryegrasses, as they have many disease problems and have poor mowing quality, especially during the warm weather of summer. These characteristics must be taken into consideration before choosing perennial ryegrasses as replacement turf.

Renovation will be necessary for those lawns where the primary purpose of overseeding is due to an infestation of perennial weedy grasses that can't be removed selectively. This usually means killing the existing vegetation with Roundup and then overseeding. Roundup should be applied at the rate of 2 oz/1,000 sq ft. The lawn should be allowed to grow to about 6 inches prior to the application of Roundup to ensure that enough chemical is absorbed by the foliage to be translocated to the quackgrass rhizome to ensure a complete kill. The lawn should be mowed prior to seeding to make overseeding more effective. Care should be exercised with the clippings as they will contain Roundup, and if placed on other

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vegetation, will cause injury and may even kill the plants. Roundup is absorbed by the soil, so it has no soil residual or activity, which accounts for the short interval time from application to seeding. The same is not true of the foliage because much of the Roundup on the foliage can be washed off.

Late summer and early fall are the best times for overseeding or renovation because the weather conditions are most favorable. Sometimes with spring seedings, warm weather will follow shortly after seeding, resulting in poor establishment. This may result in a poor quality turf or a barren lawn all summer long that will have to be reestablished in the fall. Whether you decide to overseed or renovate, careful planning should preceed undertaking the project.

WEED CONTROL RESEARCH AT THE UNIVERSITY OF ILLINOIS

Jean E. Haley

A weed is an undesirable plant because it disrupts the aesthetic appearance, stabilizing capacity, or overall utility of a turfgrass stand. Weeds also compete with the turf for water, sunlight, and nutrients. The best way to control weeds is to follow cultural practices that encourage turfgrass growth. However, if this approach is not effective, then the only alternative is to kill them with herbicides.

The high cost of pesticide development has prohibited the introduction of new herbicides used exclusively for the control of weeds in turfgrass stands. Manufacturers are evaluating new formulations of standard turfgrass herbicides and seeking data to expand the labels of products used on field crops.

The type of weed that is present determines the best approach needed for controlling it. The ideal time to control both grass weeds and broadleaf weeds is prior to their emergence from the soil. Frequently, this method of control is unsuccessful because a weed problem often isn't recognized until the weeds are large enough to be visible. Sometimes, too many preemergence herbicide applications are needed to successfullly control the weeds throughout the entire growing season. If this is the case, a postemergence herbicide will be the best means of controlling the weed problem.

CRABGRASS CONTROL

Crabgrass (*Digitaria sp.*) is most easily controlled with preemergence herbicides. In the first preemergence crabgrass control experiment, several preemergence herbicides currently used by the turfgrass industry were compared with some new herbicide formulations (Table 1). Pendimethalin is a new turfgrass formulation of a material previously labeled for corn, soybeans, and some vegetable crops. The formulation tested was Pre M 60% DG manufactured by LESCO. Another formulation of pendimethalin is also available from O.M. Scotts. Also included in this test was a new formulation of Balan (benefin) plus Treflan (trifluralin) called Team, a 2 percent granular formulation.

Herbicides were applied at the industry standard label rates. Application rates for pendimethalin were 1.5 and 3.0 lb ai/A. Team was applied at a total of 2 lb ai/A (1 lb ai/A Balan and 1 lb ai/A Treflan). Each treatment was replicated 3 times and an untreated check plot was included with each replication. Herbicides were applied on April 20 to a common Kentucky bluegrass turf. The spray volume was 40 gallons of water per acre. Data was recorded as the percent of the plot covered by crabgrass.

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On the first rating date, July 15, 1985, all treatments and rates gave good control of the crabgrass plant (Table 2). Plots were rated again on August 21, 1985. At this time, the untreated check plot had 97 percent crabgrass cover. The best control on this date was found with the 3.0 lb ai/A of pendimethalin and with benefin applied at 2 lb ai/A plus a second application 6 weeks following the first.

In a second preemergence crabgrass control experiment, bensulide was used as the standard and a different formulation of pendimethalin (10% DG) was evaluated. A higher spray volume of 152 gal/A was used. This is thought to more closely mimic the spray volumes used by the lawn care industry. Materials were applied on May 13, 1985. At this time, some crabgrass germination was observed. Despite the late application, all treatments exhibited very good control of crabgrass (Table 3). At this time, the untreated check had 50 percent crabgrass cover. On the second rating date, no statistical difference was found between the treated plots and the check plot.

A new herbicide called prodiamine was evaluated in a third field experiment. Very little is known about the effect prodiamine has on turfgrass, especially the effect over several growing seasons. A trial was established November 6, 1984, to evaluate the potential phytotoxicity of prodiamine applied over the long term and examine its ability to control winter annuals and crabgrass.

This evaluation consists of treatments of prodiamine at 0.25, 0.38, 0.50, 0.75 and 2.0 lb ai/A and Dacthal at 5.25, 10.5 and 21.0 lb ai/A. Dacthal at the 1/2, 1 and 2 times recommended label rates is included as an industry standard for preemergence weed control. Herbicides were applied to one set of plots in the fall (November 6, 1984 and October 3, 1985) and to another set of plots in the spring (April 20, 1985). An untreated control is included in each fall and spring application for all replications. Materials were applied using a CO_2 propelled backpack sprayer in a spray volume of 40 gallons of water per acre to 3 by 10 foot plots of common Kentucky bluegrass.

In 1985, crabgrass control was excellent with all spring applications of Dacthal and with all spring and fall applications of prodiamine (Table 4). Late in the season, crabgrass germination was observed in plots with spring applied Dacthal at 5.25 lb ai/A, spring applied prodiamine at 0.25, 0.38 and 0.5 lb ai/A, and fall applied prodiamine at 0.25, 0.38, 0.5 and 0.75 lb ai/A. Minor to moderate turfgrass injury was found on plots treated with prodiamine, especially with the fall applied rate of 2.0 lb ai/A. This injury did not last long. A two-foot section of each plot was scalped (mowed down to bare soil) on July 23, 1985. No difference in turfgrass regrowth was observed among treatments.

POSTEMERGENCE CRABGRASS CONTROL

If crabgrass isn't controlled prior to emergence from the soil, there are materials available to control it once germination has occurred. The most frequently used of these postemergence control materials is MSMA (Daconate 6). A turf label is currently being sought for fenoxaprop (Acclaim). This material has been used as a preemergence herbicide in field crops.

An experiment was designed to compare preemergence control of Acclaim with Daconate 6 at three stages of crabgrass growth. Herbicides were applied at the 3 leaf-1 tiller stage, the 2-4 tiller stage and the 4-6 tiller stage. Increasing

rates of fenoxaprop were used as the plant size increased. The label rate of Daconate 6,2 lb ai/A with a second application of this rate was used 7 to 10 days later. The spray volume was 152 gallon/A.

All treatments made at the 3 leaf-1 tiller stage of growth, applied on June 19, 1985 gave excellent crabgrass control (Table 5). Treatments for the 2-4 tiller stage of growth were applied July 18, 1985. At this stage of growth MSMA provided good control. However, there was significantly less crabgrass found in plots treated with both rates of Acclaim than with either the check or MSMA (Table 6). Crabgrass had reached the 4-6 tiller stage July 29, 1985 when treatments were applied. Again there was significantly better control with fenoxaprop than with the MSMA (Table 7).

BROADLEAF WEED CONTROL IN TURF

There are many formulations and mixes of 2,4-D, MCPP (proprionic acid) and Dicamba available for broadleaf weed control turf. What usually works best for a wide range of broadleaf weeds is a mix of 2,4-D, MCPP and Dicamba. Some new materials evaluated for broadleaf weed control in turf are triclopyr, dichlorprop (2,4-DP) and chlorsulfuron (Telar).

The first experiment evaluated plantain and clover control. Herbicides were applied on July 2, 1985 in 3.5 gallons of water per 1,000 square feet (Table 8). Plot size was 3 by 8 feet, and each treatment was replicated 3 times. An untreated check was included within each replication. Weed control evaluations were made on a scale of 1 to 9, where 9 equaled a large, healthy weed population and 1 equaled no weeds present. Ratings were made August 13, 1985.

Excellent control of both plantain species was obtained with all materials at all rates (Table 9). Good control of white clover was found with all materials at all rates (Table 9). However, white clover control ratings of 2 or lower were found with EH 680 at 3 pt product/A, EH 791 at 3 pt product/A, Turflon D at 4 pt product/A, and Riverdale Triamine at 4 pt/A.

Although violets can be a lovely ornamental, a wild violet infestation can detract from the appearance and utility of a lawn. An experiment was established in a Kentucky bluegrass lawn to evaluate wild violet control. The same products were used as in the plantain/white clover control experiment. Also included in this trial were three rates of CGA 131036 and 1 rate of Telar (Table 10). Herbicides were applied May 21, 1985 in 3.5 gallons of water per 1,000 square feet. Plot size was 3 by 6 feet and each treatment was replicated 3 times. An untreated check plot was included within each replication. Weed control evaluations were recorded as the percent decrease of wild violets in the treated plots when compared with the check. Ratings were made July 21 and August 21, 1985.

The best control of wild violets on the July rating date was found with all rates of Turflon D, Turflon Superamine, CGA 131036, and Telar (Table 9). By August, only Turflon D at 4 pt product/A, Turflon Superamine at 4 pt product/A, CGA 131036 at 25 gram ai/A, and 60 gram ai/A and Telar provided 75 percent or greater control (Table 9). This would indicate that with some materials at lower rates, a second application of herbicide is needed later in the season for the best control of wild violets.

If you are interested in any of these new products or formulations, contact your herbicide dealer. When using any herbicide, be sure to follow the label instructions that suit your particular situation. The best weed control program will be useless unless you follow maintenance practices that promote a strong, healthy turf stand.

Table 1. Some Herbicides Used for Preemergence Control in Turf[1]

Active ingredient	Trade name
DCPA	Dacthal 75WP
Benefin	Balan 2G
Bensulide	Betasan 4EC
Benefin + Trifluralin	Team 2G
Pendimethalin	Pre M 60% DG

Table 2. Percent of Plot Covered with Crabgrass. Herbicides Applied April 20[1]

Herbicide	Rate lb ai/A	Percent cover 7/15	8/21
DCPA	10.5	1e	18cd
Bensulide	7.5	2de	23cd
Benefin	2.0	4c-e	30c
Benefin	2 + 2	1e	10d
Benefin + Trifluralin	1 + 1	1e	17cd
Pendimethalin	1.5	3de	23cd
Pendimethalin	3.0	1e	8d
Check	...	47a	97a

Table 3. Percent of Plot Covered with Crabgrass. Herbicides Applied May 13, 1985[1]

Herbicide	Rate lb ai/A	Percent cover 7/15	8/21
Bensulide	7.5	7bc	37
Pendimethalin	1.5	2c	20
Pendimethalin	3.0	1c	10
Check	...	50a	53

[1]All values represent the mean of 3 replications. Means in the same column with the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Difference Test.

Table 4. The Evaluation of Prodiamine for Control of Crabgrass in a Kentucky Bluegrass Turf[1]

Material	Rate lb ai/A	Application time[2]	Percent crabgrass[3] 7/02	7/15	Phytotoxicity[4] 8/21	5/30
Dacthal	5.25	Spring	0.0d	10.3d	35.0de	9.0a
Dacthal	5.25	Fall	10.3b	35.0b	80.0bc	9.0a
Dacthal	10.0	Spring	0.0d	0.3d	2.3g	8.7a
Dacthal	10.0	Fall	7.0bc	26.7bc	61.7c	8.7a
Dacthal	21.0	Spring	0.0d	0.0d	0.7g	9.0a
Dacthal	21.0	Fall	0.0d	0.7d	15.0gf	9.0a
Prodiamine	0.25	Spring	0.3cd	3.7d	26.7d-f	8.7a
Prodiamine	0.25	Fall	1.0cd	13.3cd	61.7c	8.3ab
Prodiamine	0.38	Spring	0.3cd	2.3d	15.0fg	8.7a
Prodiamine	0.38	Fall	0.7cd	4.0d	40.0d	8.7a
Prodiamine	0.5	Spring	0.3cd	2.3d	15.0fg	8.3ab
Prodiamine	0.5	Fall	0.3cd	1.0d	36.7de	8.3ab
Prodiamine	0.75	Spring	0.0d	0.3d	0.7g	7.7b
Prodiamine	0.75	Fall	0.0d	1.0d	18.3e-g	8.3ab
Prodiamine	2.0	Spring	0.0d	0.0d	0.0g	8.3ab
Prodiamine	2.0	Fall	0.0d	0.0d	0.3g	6.3c
Check	...	Spring	31.7a	73.3a	93.3ab	9.0a
Check	...	Fall	30.0a	70.0a	100.0a	9.0a

[1]All values represent the mean of 3 replications. Means in the same column with the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Difference Test.
[2]Fall applications were made November 6, 1984 and October 3, 1985. Spring application was made April 20, 1985.
[3]Percent crabgrass represents the area of the treated plot covered by crabgrass plants.
[4]Phytotoxicity evaluations are made on a 1 to 9 scale where 9 equals no visible phytotoxic effects and 1 equals complete necrosis.

Table 5. The Evaluation of Herbicides for Postemergence Control of Crabgrass Applied at the 3 Leaf to 1 Tiller Stage of Growth on June 19, 1985[1]

Herbicide	Rate lb ai/A	Percent cover of plot with crabgrass 7/02	7/15	8/21
Acclaim	0.12	0.7b	8.3bc	66.7a-d
Acclaim	0.18	0.7b	2.3c-e	65.0a-e
Daconate 6	2 + 2*	2.3b	2.3c-e	55.0b-e
Check	...	16.7a	31.7a	98.3a

[1]All values represent the mean of 3 replications. Means in the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Different Test.

*The second application was made 10 days following the first application.

Table 6. The Evaluation of Herbicides for Postemergence Control of Crabgrass Applied at the 2-4 Tiller Stage of Growth on July 18, 1985[1]

Material	Rate lb ai/A	Percent cover 8/21
Acclaim	0.18	5.3c
Acclaim	0.25	1.0c
Daconate 6	2 + 2*	18.3b
Check	...	86.7a

Table 7. The Evaluation of Herbicides for Postemergence Control of Crabgrass Applied at the 4-6 Tiller Stage of Growth on July 29, 1985[1]

Material	Rate lb ai/A	Percent cover 8/21
Acclaim	0.25	1.0c
Acclaim	0.35	1.0c
Daconate 6	2 + 2*	13.3b
Check	...	98.3a

[1]All values represent the mean of 3 replications. Means in the same column with the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Difference Test.

*The second application was made 10 days following the first application.

Table 8. Herbicides Evaluated for Postemergence Control of Broadleaf and Buckhorn Plantains, White Clover and Wild Violets

Herbicide	Active ingredients	Manufacturer
EH 680 ester formulation	2,4-D, MCPP, Dicamba	PBI/Gordon Corp.
EH 791 ester formulation	2,4-D, MCPP, Dicamba	PBI/Gordon Corp.
EH 637 amine formulation	2,4-D, MCPP, Dicamba	PBI/Gordon Corp.
EH 553 amine formulation	2,4-D, MCPP, Dicamba	PBI/Gordon Corp.
Turflon D ester formulation	2,4-D, Triclopyr	Dow Chemical
Turflon Superamine	2,4-D, Triclopyr	Dow Chemical
Riverdale Triamine Chemical Company	2,4-D, MCPP, 2,4-DP	Riverdale
Riverdale Ester Chemical Company	2,4-D, MCPP	Riverdale
CGA 31036 20DG*	...	Ciba-Geigy
Telar 75DG*	Chlorsulfuron	DuPont

*These materials were tested only in the wild violet control evaluation. They were applied in a 0.25 percent v/v solution of the surfactant X77.

Table 9. Postemergence Control of Plantain and Clover Six Weeks Following Herbicide Application[1]

Material	Rate	Weed control[2]	
	Pints products/A	Plantain	White clover
EH 680	3.0	2.0b	1.0d
EH 791	3.0	1.7b	2.0b-d
EH 637	4.0	2.3b	4.3bc
EH 553	4.0	1.3b	3.0b-d
Turflon D	3.0	2.7b	4.3bc
Turflon D	3.5	2.3b	4.3bc
Turflon D	4.0	2.0b	1.7cd
Turflon Superamine	3.0	2.0b	4.7b
Turflon Superamine	3.5	1.3b	2.3b-d
Turflon Superamine	4.0	1.3b	3.3b-d
Riverdale Triamine	3.0	3.0b	3.7b-d
Riverdale Triamine	4.0	2.0b	1.7cd
Riverdale Ester	3.0	1.3b	3.7b-d
Check	...	9.0a	9.0a

[1]All values represent the mean of 3 replications. Means in the same column with the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Difference Test.
[2]Weed evaluations are made on a scale of 1-9, where 9 = no control of the weed species and 1 = no weeds present.

Table 10. Evaluation of Herbicides for Wild Violet Control in a Kentucky Bluegrass Turf[1]

Material	Rate	Percent control[2]	
	Pints product/A	7/21	8/21
EH 680	3.0	40.8bc	36.7e-h
EH 791	3.0	41.4bc	46.2e-g
EH 637	4.0	39.4bc	29.0f-h
EH 553	4.0	41.7bc	29.2f-h
Turflon D	3.0	85.9a	59.4c-e
Turflon D	3.5	96.1a	72.8b-d
Turflon D	4.0	87.0a	75.3a-d
Turflon Superamine	3.0	82.2a	44.4e-g
Turflon Superamine	3.5	90.3a	72.5b-d
Turflon Superamine	4.0	94.7a	80.2a-c
CGA 131036	10 grams ai/A	84.6a	53.7d-f
CGA 131036	25 grams ai/A	97.4a	90.4ab
CGA 131036	60 grams ai/A	100.0a	100.0a
Telar	25 grams ai/A	100.0a	93.7ab
Riverdale Triamine	3.0	46.7b	26.7gh
Riverdale Triamine	4.0	50.0b	17.8h
Riverdale Ester	3.0	21.7c	21.7gh

[1]All values represent the mean of 3 replications. Means in the same column with the same letter are not significantly different at the 0.05 level as determined by Fisher's Least Significant Difference Test.

[2]Percent control represents the percent decrease of wild violets in the tested plots when compared with the untreated check.

WHAT IS BUFFALOGRASS?

John C. Fech

Buffalograss is a low growing, sod forming, warm season grass which is native to the North American Great Plains. Buffalograss is a dioecious or occasionally monoecious perennial, having male and female plants occuring within the same stand. Male plants produce staminate culms, 5 to 6 inches tall, containing orange-red anthers. Female plants produce single-flowered pistillate spikelets in burrlike clusters, more or less hidden in the leafy portion of the stand. Leaves are a grey-green color, finely textured, and hairy on one or both sides. New plants are produced by seed and by wiry, spreading stolons (Figure 1).

Because buffalograss is a warm season species, its growing season is shorter than cool season species such as Kentucky bluegrass and tall fescue. Buffalograss begins growing actively in midspring and goes dormant in midfall. Dormancy is induced by decreasing photoperiod, low light intensity, and cool temperatures. The peak period of growth is in midsummer, when many cool season turfgrasses are stressed.

For many years, buffalograss has been used to pasture livestock and for soil conservation purposes. A growing interest is currently developing to use buffalograss as a turf. Suggested, appropriate sites for the use of buffalograss include institutional grounds, golf courses, airfields, roadsides, and novelty home lawns. These sites are generally considered to be low maintenance areas.

There are many advantages to utilizing buffalograss as a turf species:

- Low fertility requirement--0 to 1 lb N/1,000 sq ft/yr
- Low irrigation requirement--1 in/month
- Excellent heat and drought tolerance
- Low thatching tendency
- Infrequent mowing
- Good recuperative potential
- Good disease/insect tolerance
- Tolerates submerged conditions (2 to 3 weeks)

These attributes will permit a culture of buffalograss under a low maintenance regime.

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However, there are several disadvantages to the use of buffalograss as a turf. The major objection is the duration of active growth. Generally, the maximum growth period is 5 months. Many users of a turfgrass would like to have a green sward for 8 to 9 months. Another drawback is that buffalograss is relatively slow to establish, requiring one year. Many persons object to the grey-green color, preferring an emerald dark green. Buffalograss is not adapted to shady conditions, limiting the sites where it can be grown to full sun exposures. Under minimal mowing schedules, the male flowers grow to be 2 to 3 inches taller than the intended height of cut. This, too, is found to be undesirable by some persons.

Buffalograss is established by seed, in late spring or early summer. Before seeding, the site is prepared in the traditional manner for Kentucky bluegrass establishment. A seed drill is used to place the seed one-fourth to one-half inch into the soil. Seeding rates depend on the amount of irrigation available, number of competing weeds, and desired time for establishment. A range of 50 to 100 pure live seed (PLS)/sq ft, or 1 to 2 lb PLS/1,000 sq ft, or 40 to 80 lb PLS/acre is suitable for most conditions.

To determine the number of bulk pounds of seed for use, divide the pounds of PLS needed by the percent PLS tested. The percent PLS tested can be obtained by multiplying the germination rate by the percent of pure seed in the bag. This information is readily obtained from the seed label. An example of this calculation follows: 1.9 lb PLS needed divided by the product of 82.13 percent pure seed, and 75 percent germination (62.1) equals 3.1 lb of bulk seed to use per 1,000 sq ft.

Studies will be undertaken to determine the proper cultural and maintenance conditions under Illinois conditions. Mowing height, mowing frequency, irrigation frequency, fertilizer scheduling, and herbicide necessity/phytotoxicity are the factors which need to be investigated.

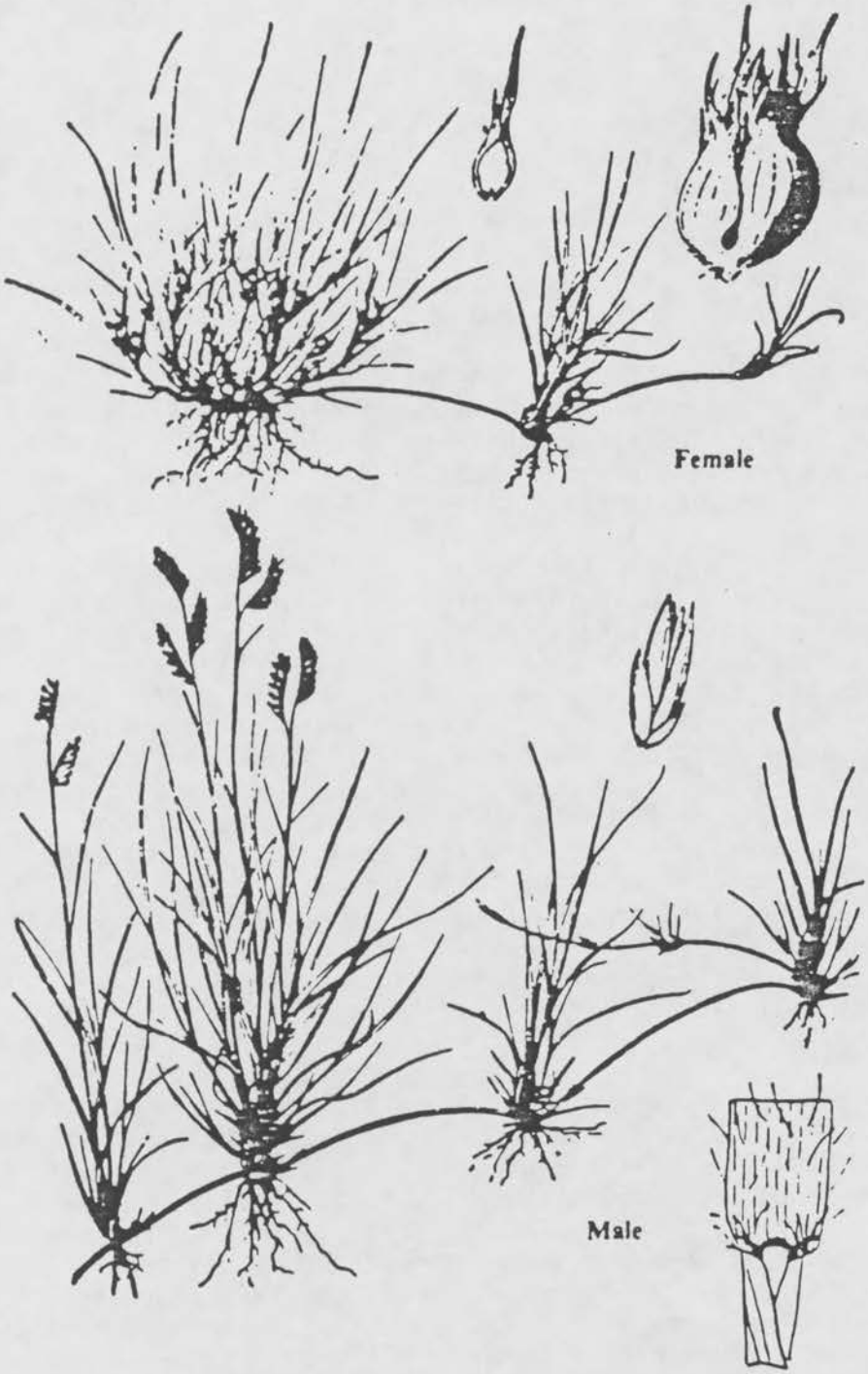

Figure 1. Female and male buffalograss plants, copied from Hitchcock

WHAT'S NEW WITH TURFGRASS DISEASES AND FUNGICIDES

Malcolm C. Shurtleff

The occurrence and prevalence of turfgrass diseases are constantly changing: as turfgrass cultivars are changed in blends or mixes, fertilizer types, amounts and schedules, mowing height or frequency, dethatching and aerification procedures, topdressing or other cultural management practices, the air and/or soil environment around turfgrass plants is changed and increases or decreases their susceptibility to disease. New diseases are constantly appearing on the scene as management practices are changed and a few older ones tend to fade away.

The leaf spots and blights prevalent in 1985 were the older Septoria and Ascochyta leaf spots or blights, but a new one appeared, which had never been seen before, the Leptosphaerulina leaf blight. It is very difficult to tell these three diseases apart through symptoms alone. Under a microscope, however, the characteristic spores produced by the three fungi are easily distinguished.

Septoria leaf spot or tip blight is an old disease caused by about 15 species of the fungus *Septoria*. At least three species attacking Kentucky bluegrass, fescues, and perennial ryegrass were found this year. Disease attacks commonly occur during cool, wet weather in late winter or early spring, as the grass greens up, and then again in autumn. The overall appearance of a diseased turf often resembles damage from a dull mower. The grass leaves are commonly a pale yellow from the tip downward. The leaf spots are gray to gray-green or brown before fading to a light straw color. *Septoria* produces dark, speck-sized fruiting bodies, called pycnidia, in the older lesions. When the pycnidia are placed under a microscope, the long needle-lie spores emerge in large numbers. The *Septoria* fungi overseason in grass debris. The fungi are spread about mainly by splashing and flowing water and by turfgrass equipment. No special measures are usually needed to keep Septoria leaf spot in check. The fungicides applied to control "Hellminthosporium" diseases and dollar spot should provide adequate control. Kentucky bluegrass cultivars differ greatly in their susceptibility to Septoria leaf spot.

The second leaf blight disease is Ascochyta leaf spot or blight. There are approximately 20 species of this fungus that infect all types of northern turfgrasses. In the Plant Clinic at the University of Illinois, at least two species of *Ascochyta* were found infecting Kentucky bluegrass in 1985. *Ascochyta* is capable of blighting large turf areas although the disease is more common in localized areas giving diseased grass a patchy appearance. Individual leaves commonly die back from the tip to the leaf sheath. Dark, speck-sized fruiting bodies (pycnidia) form in the centers of older spots. Without a microscope it is difficult to tell *Ascochyta* from *Septoria*. Under a microscope one can see that the

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spores of *Ascochyta* are much shorter and thicker than those of *Septoria* and are two-celled when mature. Both *Septoria* and *Ascochyta* were found on the same leaf blade in a few cases.

Ascochyta has the same general disease cycle as *Septoria*. The spores, which are produced in tremendous numbers, are spread by splashing or flowing water, mowers, and other turfgrass equipment. Unlike *Septoria*, which is seen only in cool wet weather, Ascochyta blight occurs throughout the growing season. Periods of damp weather or frequent irrigations lead to disease attacks during the summer months. Frequent mowing favors infection by both *Ascochyta* and *Septoria* by creating potential infection sites. Information regarding the relative resistance of turfgrass cultivars to *Ascochyta* is lacking and no information is available on the most effective fungicides.

The last of the three leaf blights is caused by the fungus *Leptosphaerulina australis*. This is the first year it has been widespread, not only in Illinois, but throughout much of the Northeast and Midwest. It is primarily a warm-to-hot weather disease of perennial ryegrass and Kentucky bluegrass, although we found it commonly on creeping bentgrass. It caused a yellow dying back of the leaves, especially on golf greens cut at 2/16 to 3/16 inch. Leptosphaerulina leaf blight is easily confused with Nigrospora leaf blight, Ascochyta and Septoria leaf blights, Pythium blight, and dollar spot. The disease was found to be active from early spring (often in combination with Septoria and Ascochyta leaf blights) into autumn on Kentucky bluegrass. Large areas of turf may become uniformly blighted or patchy with individual leaves dying back from the tip. The *Leptosphaerulina* fungus, like *Septoria* and *Ascochyta*, produces brown, speck-sized fruiting bodies, called perithecia, in dead grass tissue. When the fruiting bodies are crushed under a microscope, saclike structures, called asci, each containing 8 ascospores, can be readily seen. The multicelled spores have both cross and vertical walls and are easily identified. The spores are transported about in the same manner as are *Septoria* and *Ascochyta*--by splashing or blowing about and being carried on turfgrass equipment and shoes. Disease outbreaks are most common during warm, humid, or wet weather when turf is stressed by close mowing, drought, herbicides, or on newly laid sod that lacks good root contact with the underlying soil. No information is available for Leptosphaerulina leaf blight as regards cultivar susceptibility or the effects of different fungicides.

Dr. Clint Hodges in Iowa reported this year on two species of the fungus *Pythium* that colonize the secondary roots of creeping bentgrass in golf greens with a high sand content of 90 percent or more. Infection by *Pythium aristosporum* and *Pythium arrhenomanes* resulted in slower growth and an off-color to the creeping bent and a thinning out of grass plants which had stunted white roots. These and other species of *Pythium* cause more root rot and damage than is generally recognized to the crowns of all types of turfgrasses in cool (60°F), warm, and hot weather. *Pythium* fungi are commonly present in diseased turfgrass, thatch debris, and soil in the form of delicate, nonseptate mycelium and round, thick-walled resting spores embedded in dead grass tissue. Disease development is greater with a thick thatch and with high-nitrogen fertility or a high level of balanced fertility than with a low-fertility level. Pythium blight is most severe in dense lush grass in low-lying wet areas that have poor soil drainage and where air movement is nil. Control measures involve applications of Subdue or Banol at 2- or 3-week intervals. These fungicides and others, such as Koban, Teremec SP, or Terraneb SP, should be rotated to avoid resistance problems that have appeared through frequent applications of Subdue.

Other controls for Pythium blight include increasing air movement and improving soil drainage. Avoiding an excess of water on the grass surface and in the root zone is of major importance.

Yellow ring is a disease of Kentucky bluegrass that was reported last year. It is most evident on heavily thatched turf that has sufficient water and nutrients to remain green and lush during the entire growing season. Yellow ring is mostly a problem on sod that is over 18 months old with a thatch over an inch thick. The causal fungus, *Trechispora alnicola*, feeds largely on dead grass in the thatch where it forms a dense, white mycelial growth that may be an inch or more thick. This dense white growth is found beneath the yellowed leaves. The control for yellow ring is to grow Kentucky bluegrass at a slower rate using less fertilizer and water. Cutting and selling the sod when it's young also solves the problem, at least for the sod grower. Dr. Wilkinson found that applications of PCNB or Terraclor stopped the progression of yellow ring but did not cause a remission of symptoms.

Zoysia patch is another new disease. It has now been reported from New York, Ohio, Tennessee, Arkansas, and Kansas, as well as Missouri, on sod farms, home lawns, and golf course fairways. Dr. Wilkinson's research group has not yet identified the causal organism but he strongly suspects that zoysia patch is caused by a dark, ectotrophic fungus closely related to the *Gaeumannomyces* fungus that causes take-all patch disease. According to Dr. Wilkinson, zoysia patch is definitely not *Leptosphaeria korrae*, the cause of spring dead spot of bermudagrass and necrotic ring spot. Like *Leptosphaeria* and *Gaeumannomyces*, the zoysia patch fungus produces dark mycelial strands that grow over the roots of diseased grass plants.

Zoysia patch is active in the spring as the zoysiagrass breaks dormancy. The patch often develops a red-yellow band up to 8 inches wide at the outer edge. The band disappears as temperatures rise above 75 to 80°F. The disease is again active in the fall as cooler temperatures start to slow down growth of the zoysiagrass. The patches grow out radially each season at the rate of up to 6 feet or more. Diseased areas may become irregular as individual patches merge. These areas are commonly invaded by grassy and broadleaf weeds. No control measures are known at present. The cause of zoysia patch must first be identified and then more found out about its biology.

At last year's conference in Chicago, a discussion was held on patch diseases, which concentrated on what was formerly called Fusarium blight or Fusarium blight syndrome. Two diseases, summer patch and necrotic ringspot, make up what used to be called Fusarium blight. These diseases are difficult to control, primarily because their biology and development is not fully understood. Summer patch, necrotic ring spot, and perhaps other components of the Fusarium blight syndrome, produce symptoms that are indistinguishable from each other.

Summer patch is caused by the soilborne fungus *Phialophora graminicola*, which has a sexual or telomorph stage of *Gaeumannomyces cylindrosporus*, a species closely realted to the take-all fungus. It is weakly pathogenic at temperatures below about 70°F. Summer patch becomes a serious disease when hot, sunny days follow warm-to-hot, very wet periods.

The soilborne fungus *Leptosphaeria korrae* causes necrotic ring and is favored by cool to mild temperatures and dry to wet conditions from spring to autumn.

This disease is most severe in spring and autumn. *Phialophora* and *Leptosphaeria*, which are very closely related, also closely resemble the take-all fungus *Gaeumannomyces graminis* var. *avenae* in their dark mycelial growth ("runner hyphae") over the roots, crowns, and rhizomes of grass plants at the edges of the patches, and in their disease development. Also associated with these diseases are one or two presently unidentified primary pathogens as well as species of *Fusarium*, which are very widely distributed but secondary pathogens or saprophytes. The *Fusarium* fungi may accelerate the expression of symptoms, but are not essential to the final expression of disease. Many other fungi, including species of *Curvularia*, the anthracnose fungus, *Drechslera*, *Pythium*, *Rhizoctonia*, *Alternaria*, and *Stemphylium* can also serve as secondary colonizers of the weakened grass plants, thereby substituting or coexisting with the *Fusarium* species.

Grasses susceptible to one or more parts of this disease complex include Kentucky and annual bluegrasses, several commonly grown fescues, colonial and creeping bentgrasses, Italian and perennial ryegrasses, bermudagrass, zoysiagrass, and many other forage, wild, and weed grasses, and even small grains.

Summer patch and necrotic ring spot can become severe when turfgrasses, especially Kentucky bluegrass, are entering summer dormancy, although infection may have occurred several months earlier during cool weather. Prolonged periods of high humidity and warm-to-hot weather with temperature ranges of 75 to over 100°F during the day and above about 70°F at night favor disease development. Moisture and heat stress, excessive watering, close mowing, a thick thatch with a pH of above 7 or below 5, unbalanced applications of fertilizer (an excess of nitrogen and low levels of potassium and/or phosphorus), high populations of parasitic nematodes, such as the stunt nematode (*Tylenchorhynchus dubius*), compaction, and other factors that predispose turf to stress conditions usually increase the severity of these diseases. The abiotic factors that most influence disease development appear to be related to the soil and thatch environments. In particular, the factors responsible for the rate of thatch decomposition, including good aeration under warm, moist conditions and an acidic or alkaline pH, are strongly implicated. These diseases of Kentucky bluegrass are generally not evident until the second or third year on newly laid sod and usually not for four years or more after seeding when the thatch has accumulated to over 1/2 inch.

The fungi causing summer patch and necrotic ring spot are believed to have the same disease cycle as for the take-all patch fungus. These fungi all grow radially outward at the rate of two to three inches per year for several years. Any one patch may "die out" or disappear after reaching a certain size, usually 1 to 3 feet in diameter.

To control summer patch and necrotic ring spot, avoid as many environmental stresses as possible to keep the turfgrass growing steadily. Heat stress can be reduced on hot and humid days by briefly syringing the turf one or more times during midday, keeping the grass mowed to the highest recommended height, and removing no more than one-fourth to one-third of the leaf surface at one cutting. Grass height should be increased during the warmer months. Keep the soil and thatch pH between 6.5 and 7 by applying small amounts of lime or sulfur at frequent intervals based on a soil test, but avoid excessive applications. Adequate moisture should be maintained, especially on south and west-facing sunny slopes and other sites (such as near parking lots, driveways and sidewalks) that dry out faster and have higher thatch and soil temperatures than slopes facing east or north. Soaker hoses should be used on slopes where water tends to run off

instead of slowly infiltrating the soil. Where possible, water should be applied in the morning so that the grass will dry before dusk. Restrict the use of herbicides.

Avoid pure stands of very susceptible cultivars of Kentucky bluegrass to summer patch and/or necrotic ring spot. Plant a blend of several Kentucky bluegrass cultivars that have good tolerance or resistance.

The blending of 15 to 20 percent seed by weight of a turf-type perennial ryegrass mix (for example, All-Star, Birdie II, CBSII, Citation II, Derby, Manhattan II, and Omega II) with seed of resistant Kentucky bluegrass cultivars will sharply reduce the incidence of summer patch and necrotic ring spot. Overseeding diseased turf with the new perennial ryegrasses or resistant cultivars of Kentucky bluegrass also provide control. Cultivars of Kentucky bluegrass, perennial ryegrass, and tall fescue differ in their resistance to summer patch disease.

Where cultural controls are not feasible or do not adequately control this disease complex, several systemic fungicides are available. The fungicides should be applied *before* disease symptoms become active that season. Applications should start in late spring and be repeated at intervals during the summer. Rubigan and Banner are the only fungicides that control both summer patch and necrotic ring spot. Bayleton, another ergosterol-inhibiting fungicide, is effective only against summer patch. Banner has recently been registered and labeled for control of summer patch and necrotic ring spot.

NEW FUNGICIDES

Some new turfgrass fungicides include Duosan and Vorlan plus Banner, Rubigan, Bayleton, and Subdue, which have already been mentioned.

Duosan, a Mallinckrodt product, is a combination of thiophanate-methyl and mancozeb. It is a broad-spectrum foliar fungicide which has both protectant-contact and systemic activity. Duosan is effective against a number of major turfgrass diseases including "Helminthosporium" leaf spots and blights, dollar spot, red thread, Rhizoctonia brown patch, rust diseases, Fusarium patch, and anthracnose. The label may be even further expanded in the future. Its sister compound, Zyban, is one of the best multi-purpose fungicides for woody and nonwoody ornamentals.

Vorlan is another Mallinckrodt product for use on turf. Ronilan is a sister compound from Ciba-Geigy for use on field crops. Ornalin, another Mallinckrodt product, is used on herbaceous and woody ornamentals. Vorlan, a protective-contact foliar fungicide, controls "Helminthosporium" leaf spots and blights, dollar spot, red thread, Fusarium patch, and Rhizoctonia brown patch. The Vorlan label is expected to be expanded in the future. The mixture of Vorlan and Fungo 50 is now available for tank mixing to give long-lasting, protective-contact, systemic, and curative activity.

Banner is a new Ciba-Geigy, broad-spectrum, systemic fungicide for use on turfgrass while Tilt has been developed for field crops. As mentioned earlier, Banner controls both summer patch and necrotic ring spot. It also does an excellent job in controlling dollar spot and red thread and may be labeled soon for control of anthracnose, powdery mildew, rusts, leaf smuts, snow molds, and certain leaf spots including those caused by "Helminthosporium." Outside the United

States, propiconazole (Banner or Tilt) is sold in various combinations with other fungicides, including Daconil 2787. It is available both as an emulsifiable concentrate and as granules.

Bayleton, a Mobay product, has been around now for several years. We have already mentioned that it controls summer patch but not necrotic ring spot. Bayleton is a long-lasting systemic fungicide that controls dollar spot, red thread and pink patch, rust diseases, Rhizoctonia brown patch, anthracnose, leaf smuts, and snow molds. On other crops it is labeled for control of powdery mildews, other leaf spots, blossom blights, and certain fruit rots. Bayleton is sometimes combined with mancozeb to provide even broader spectrum control or to prevent development of fungicide-tolerant or resistant fungal strains.

Rubigan has been available now for several years. This Elanco product is a broad-spectrum, locally systemic, foliar fungicide. It is labeled for control of dollar spot, Rhizoctonia brown patch, leaf smuts, anthracnose, snow molds and "Fusarium blight" (a complex of summer patch and necrotic ring spot). Rubigan may be labeled some day for the control of powdery mildew and rust diseases as it now is for other crops.

Subdue is one of the very best fungicides for controlling Pythium blight. It is also the only labeled fungicide for control of yellow tuft. Subdue provides long-lasting, systemic, and curative control of both diseases when applied on a *preventive* basis. Apron is a seed treatment containing the same active ingredient as Subdue. The use of Apron on grass seed, in combination with captan or thiram, to control seed decay, damping-off, and seedling blights caused by a complex of fungi is suggested. These fungi include species of *Pythium*, *Fusarium*, and *"Helminthosporium," Rhizoctonia solani*, and *Colletotrichum graminicola*. If a combination seed treatment is applied prior to planting, seeding rates could be reduced by 20 percent or more. Seed treatment of grass seed is a cheap form of insurance to ensure a healthy, vigorous, thick, stand of grass seedlings.

Some other fungicide news for 1986 includes:

1. DuPont has dropped some Manzate products, Tersan LSR, and Tersan SP. Teremec SP and Terraneb SP, however, contain the same active ingredient as Tersan SP and are suggested for control of snow molds and Pythium blight.

2. Dyrene will be available in a new flowable formulation in 1986. A number of wettable powder pesticides are now available in flowable formulations. A flowable is a very finely divided wettable powder that will stay in suspension for weeks or months. This means fewer problems with nozzle plugging. Flowables are designed for use in all types of ground and air spray equipment.

3. Daconil flowable will now come in a larger container (2 1/2 gallons) instead of the old 2-gallon jug.

4. Upjohn sold its Acti-dione products to Nor-Am in 1985. For fungicides, Nor-Am now has Banol for the control of Pythium blight and the Acti-dione products that control a spectrum of turf diseases.

RYEGRASSES

C. R. Skogley

Ryegrass is of the genus *Lolium*. Hitchcock, in his "Manual of the Grasses of the United States," lists six species as present in the U.S. Five of them are annual and only two have agricultural and turfgrass usage. The two are *Lolium perenne*, known as "perennial" ryegrass, and *Lolium multiflorum* commonly called "Italian" or "annual" ryegrass.

Both of these grasses were introduced into North America from Europe where they had long been prime pasture and hay grasses. They were not well accepted in this country for either forage or turf purposes as grasses were found which were better suited for both usages. Unimproved ryegrasses were either of too short duration in our varied climates or not sufficiently productive. They have been used for turf purposes for many years but with little support or enthusiasm from turfgrass specialists. Reasons given for this lack of acceptance were that the "perennial" wasn't really "perennial" and it was really too coarsely textured to provide good looking turf. In colder climates of the U.S. most "perennial" ryegrass plants would winter kill, but a few plants often remained to provide spotted clumps throughout a lawn--rather like tall fescue in northern climates. Annual ryegrass, on the other hand, is too aggressive in seed mixtures. It is coarsely textured and usually dies from heat or cold stress within one season when mowed at lawn height. Despite the lack of quality in these unimproved grasses, they have been sold, and are still being sold, in vast quantity in "junk" or cheap seed mixtures. They germinate and establish fast, great characteristics for the unwary homeowner or less than scrupulous landscape gardener.

Annual ryegrass should be considered only for temporary lawns or ground cover, and improved, "turf-type" perennial ryegrass for all other turf purposes. The modern, turf-type ryegrasses do not resemble their common namesake. The release of the cultivar Manhattan by Dr. Reed Funk, at Rutgers University in 1967, and Pennfine by Dr. Joe Duich, at Pennsylvania State University in 1970, changed turfgrass management. Perennial ryegrass now contributes greatly to our effort to provide quality turf with greater success.

Compared with common perennial ryegrasses, the turf-types have finer leaves and provide greater density. They are more attractive, persistant, resistant to more diseases, and are more shade tolerant. They are lower growing, easier to mow and can provide a beautiful turf even in a pure stand. In addition, they will tolerate more heat and cold. Like the common cultivars, they germinate and establish rapidly. They are highly wear tolerant and will grow on a wide variety of soils. Ryegrasses do, however, have several disadvantages.

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Ryegrass is still classed as a bunch grass. It does not spread by stolons or rhizomes; therefore, recovery from injury is not rapid. They remain subject to potentially damaging diseases such as brown patch, snow mold, pythium, leaf spot and red thread. Injury or loss of ryegrass which may be caused by one of these pathogens is much less likely when it is grown in combination with other adapted turfgrasses.

Stand density is generally also improved by using ryegrass in combination with other grasses. And even more important, ryegrass in mixture appears to be more winter hardy than when it is in pure stand.

Even the "turf-type" perennial ryegrasses are generally considered to lack reliable winter hardiness. In 15 years of trials in Rhode Island, where temperatures in January of 1985 reached minus 20°F, only one bad experience with winter hardiness had been encountered. During the winter of 1976-77 several inches of ice were present over our research trials for several weeks. The ice melted slowly and the frozen soil below the ice remained wet for some weeks. When spring arrived, the ryegrass plots were nearly 100 percent dead. Bluegrasses, fine fescues, and bentgrasses, subject to the same conditions, recovered fully. It may be that ryegrasses are only subject to winter kill when also subject to wet conditions.

In the light, infertile, acid, and shallow soils of New England, perennial ryegrass is found to perform better than Kentucky bluegrass at medium to lower levels of fertility. It seems to persist better and to hold better density. In addition, it has been found to tolerate closer cutting than Kentucky bluegrass.

Its usage on golf courses in the northeast has been considerable during the past ten years, especially on fairways and tees on many golf courses. Fairways and tees have improved markedly since the arrival of turf-type ryegrass.

One major concern with the use of perennial ryegrass in regions subject to cold winters is noted: its use in monostands may be unwise because of a potential weakness to cold, wet conditions and some weakness in regard to several serious diseases. Used in a mixture with bluegrass, fine fescues, and bentgrasses, overall performance will be increased.

Fairway and tees in New England should be overseeded with a mixture of 20 to 30 percent turf-type ryegrass, 5 to 20 percent Colonial bentgrass, and the remainder with Chewings fescue (only improved varieties of any grass). These grasses germinate and establish rapidly enough to compete with *Poa annua*, will tolerate fairway cutting height with reasonable management, and require moderate amounts of fertilizer under New England conditions. Kentucky bluegrass does not perform well.

Certain, newer ryegrass cultivars have another desirable attribute, the presence of an endophyte. Endophytes are internal fungal organisms that provide some resistance or immunity against sucking and chewing surface insects. Among cultivars containing a high percentage of endophytes are Repell, Citation II, Pennant, Regal, and All Star. Research is underway to incorporate the endophyte into other varieties.

There are many good turf-type ryegrasses available to turf managers, who should check on cultivar performance in their given area before making any selections. It may be well to use a blend of good varieties, also, as suggested with bluegrasses, so that the range of performance and adaptability is broadened.

The following is a summary of the strengths and weaknesses of turf-type perennial ryegrass when compared with other good turfgrasses.

Strength	Possible weakness
1. medium textured	1. winter hardiness - on wet soils
2. pleasing color	2. disease susceptibility
3. quick establishment	3. tough to cut at certain times
4. widely adapted	4. no stolons or rhizomes
5. excellent wearability	5. not shade tolerant
6. excellent root system	6. fertility requirement (more than some bents or fine fescue)
7. endophyte potential	
8. tolerance to cutting height	
9. early spring green-up	
10. holds color well into fall	
11. blends with other grasses	

GREEN BANK MAINTENANCE

Don Schumacher

For me, at the Country Club of Peoria, the worst problem I had when taking the job was maintaining the predominantly *Poa annua* green banks. By green banks, I mean the area of turf directly in front of and surrounding the greens. During this talk, I will discuss the problems I encountered, how I diagnosed these problems, how I am correcting them, and the results.

My major problem was the loss of turf on my green banks during the high stress periods in July and August. No matter how much hand watering and syringing was done, the *Poa annua* would die. Along with this problem, add the encroachment of dense populations of goosegrass. The combination of the two would make my green banks quite unsightly and not very playable. I knew steps needed to be taken to correct these problems.

The first thing I needed to do was diagnose the cause of my problems. My green banks were 90 percent *Poa annua* and this is what I blamed for my problems. The logical answer would be to get rid of the *Poa annua*. However, the club membership was totally against a total renovation program, such as using a herbicide to eliminate the *Poa annua*, fumigate, and reseed. I had to look at other options.

At this time, I decided to find out what had caused the turf to change over the years from bentgrass to the *Poa annua*. We had begun aerifying these areas in the spring, two years before. I knew how badly compacted the areas were. The first year that we did aerify, the aerifiers would hardly break through the soil surface. I assumed that compaction was the leading cause for the change from bentgrass to *Poa annua*.

A simple soil probe taken randomly on some of my banks also showed the soil to be a problem. It was a combination of heavy clay in some areas and pure sand in areas between the traps and the greens. The sand had been deposited over the years by sand shots and wind. I also knew that the irrigation system was not giving me adequate control of the water use in these areas. To maintain adequate moisture levels for the greens, the green banks were either receiving too much water in some areas or not enough in others.

Another problem I had was the large areas of turf that could be described and were being maintained as green banks: all of the areas around the greens, as far out as the outside of the sand traps, were being maintained as green banks. Along with this were severely sloped banks, which were also being maintained as green banks. On these sloped areas of turf, mowers were tearing or scalping throughout the summer, and *Poa annua* was returning rather than bentgrass.

Other maintenance procedures also needed to be questioned. I did not think disease was a problem because we had sprayed our green banks on the same schedule as our greens. Still, a disease problem had to be questioned. I then looked for errors in our fertilization techniques.

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Now that we knew what the problems were, we had to decide on the best solutions. I knew that I still wanted to convert my green banks to a predominant stand of bentgrass. This would avoid added future problems that *Poa annua* seems to bring. However, I still needed to maintain the *Poa annua* that was there to keep the banks playable throughout the season. I decided to maintain it with the best of my abilities until late August and then selectively kill or thin the *Poa annua* and immediately overseed. This will be discussed later, but first, let me describe the cultural practices that we have installed on our green banks to enhance the bentgrass populations, as well as keeping the *Poa annua* alive and well throughout the season.

As mentioned before, I felt that our compaction problem was the leading cause for the decline of the bentgrass population on the green banks. I also felt this was one of the major reasons for losing the *Poa annua* during the stress periods as well. To correct this problem, we decided to aerify the banks both spring and fall. We have been incorporating the plugs back into the turf by verticutting and dragging with a drag mat. Beginning this year, we are also going to aerify in mid-June with solid tines. I also keep my personnel aware of our compaction problems. Being sure that most of our compaction problems are a result of our maintenance equipment, I make sure my personnel do every thing possible to avoid creating problems. We hand mow our greens, and, as a result, the first two or three feet outside of the greens were our most heavily compacted areas, due to the turning of the mowers. I now insist that these turns be made at different lengths from the edge of the greens, which has helped. The operator of the turf pro 84, which is used to mow the green banks, must try to alternate the tire tracking as much as possible throughout the season. We also try to avoid mowing during wet conditions. All of these things help in reducing compaction problems.

The second problem I needed to deal with was the poor soil conditions. As stated before, I had a variety of soils, from heavy clay to pure sand. Throughout the season, I had some areas of poor drainage and other areas with localized dry spots. I felt it was imperative to correct these problems. Wherever drainage problems existed, tiles were installed and connected to the existing drainage system. To correct the localized dry spots, a wetting agent was used. It is important to start using these products in the spring, well before the dry spots are observed, and then to continue with them as labeled throughout the season. I was very pleased with the results of the wetting agent. The number and severity of the localized dry spots and the capability of the clay soil to hold moisture were improved.

The problem which worried me the most was the problem I had from the beginning. This was maintaining the *Poa annua* throughout August. As stated before, solving the compaction problems and the other soil conditions would surely help, but I knew more needed to be done.

With the high percentage of *Poa annua* I had on my banks, I wanted to maintain it as well as I could through late August. One technique I used to help maintain the *Poa annua* was a growth retardant (Embark). This is applied in late April or early May, just before the first seedheads appear. By using the growth retardant, the seedheads are suppressed, and as a result, root growth is enhanced. *Poa annua* is much more likely to survive the stress periods with a healthy, vigorous root system.

Another way to enhance root growth and to make the *Poa annua* more stress tolerant is to minimize irrigation during the spring. I try to hold off irrigating

as long as possible, usually to the wilting point before the severe stress periods beginning in late June. The longer irrigation is delayed, the more stress tolerant your turf will be.

Another way to enhance root growth is to apply a late season fertilization. I use an IBDU formulation. I try to time the application after top growth has stopped but before the ground is frozen and root growth is still occurring. By using a slow release fertilizer such as IBDU, the turf can use the nutrients for this late root growth, as well as for the early spring root growth. Another benefit from a late season fertilization is an early spring green-up.

It is also important to keep the *Poa annua* as healthy as possible in late fall, spring, and early summer, as well as during the high stress periods. I continue a fungicide program throughout the late fall and begin again in the early spring, using primarily a combination of Acti-dione (RZ and TGF) to keep the *Poa annua* healthy.

Another cultural practice I use to help prepare the *oa annua* for the stress periods is the collecting of clippings. The theory behind this is that the removal of the clippings removes the silage that accumulates within the crown level of the plant. This silage decays during hot, humid conditions. The decaying process produces heat, which can add to the stress of the grass. By removing the clippings, I try to reduce this silage effect to a minimum.

During the stress periods of July and August, other cultural techniques should be used to help maintain the *Poa annua*. Careful control of irrigation practices must be maintained. During hot, humid, and dry conditions, try to stay one step ahead of the weather with your irrigation. During these periods, do not let the *Poa annua* go into stress because of a lack of moisture. Keep the soil moist throughout the root zone, but try to avoid over-watering. This can cause additional problems such as wet wilt, added compaction problems, and tearing and scalping of mowers.

During the extreme heat of the day, it is also a good practice to syringe. Syringing is the application of just enough water to the turfgrass to get the leaf blades wet. As the water evaporates, it lowers the temperature of the grass. It may be necessary to do this more than once a day. Players do not like this, as it can interupt play. However, a little communicaiton describing why this must be done, and setting up a schedule of when it will be done, will help smooth over problems with the players.

Diseases must be controlled during the high stress periods. During high stress periods anthracnose is the disease of *Poa annua* that you should be most concerned about. There are a number of good fungicides available for control of anthracnose. It is important to apply the fungicide before the turf is severely infected. Anthracnose usually appears around mid-June, but it depends on the weather conditions. The black fruiting bodies of the anthracnose can be detected under a hand lends, so keep a close eye out for weather conditions that are condusive for anthracnose.

I also believe it is important to give the *Poa annua* small applications of nitrogen during these stress periods. I apply one quarter pound of nitrogen per thousand square feet every two to three weeks during the stress periods. This, I feel, makes the *Poa annua* healthier and more aggressive to thrive during the stress periods.

As mentioned earlier, I still wanted to convert the stands of *Poa annua* to bentgrass. I try to keep my *Poa annua* healthy until the third week of August, and then without use of chemicals, try to kill or thin it by cutting back on the irrigation. Simply, I severely wilt the turfgrass. The *Poa annua* will not survive this wilting during the extreme temperatures, but the existing bentgrass will survive. Then, right after Labor Day, we begin the process of establishing new stands of bentgrass. We begin with the aerification process. This process loosens the soil, prepares the seed bed, and breaks down chemical barriers used to prevent crabgrass and goosegrass. We incorporate the aerifying plugs back into the turf by verticutting and dragging the soil back in. We then seed the areas, using an Olathe power seeder in two directions. A starter fertilizer is then applied to the seeded areas. Additional hand watering is needed, along with normal irrigation practices, to keep the moisture levels sufficient for seed germination. This had worked very well, without disrupting play. The membership does not mind playing off of these seeded areas, knowing improvements are being made.

Because of the intensive cultural practices that were now being done to our green banks, I felt we had to reduce their size. Another reason I wanted to reduce the size of some of our banks was to avoid or change some of the severe slopes next to our greens from banks to the rough. By reducing the size of the banks, less chemicals and fertilizer are needed to maintain them; and there is less wear on the equipment that is used. At first, the membership was against the reduction in size, but I have convinced them that this would speed play and improve the playability of the golf course.

To reduce the size of our green banks, we first design the outside dimensions of the new bank, and then mark it with marking paint. We then cut out the existing bent-*Poa annua* sod with a sod cutter. Unless a large patch of bentgrass can be saved for other uses on the course, the sod is discarded. We then resod the stripped areas with improved bluegrasses. If I feel it is necessary, we aerify the area to prepare a bed for the sod. Also, if any of these areas need to be reshaped to alter water runoff, it is done at this time.

The results of my programs have been very successful. My loss of *Poa annua* in the last three years has been minimal. I have changed the populations of grass species from about 90 percent *Poa annua* to about 60 percent bentgrass and 40 percent *Poa annua*. I think that after this fall's reseeding I will have close to 75 percent bentgrass on some of our green banks. At that time I will reduce the amounts of nitrogen that will be applied to the banks. This should be detrimental to what *Poa annua* is left.

The membership is very happy with the results of my programs. They have a fine quality turf on which to play through August, and play is not disrupted during the aerifying and seeding process.

In conclusion, if you have problems maintaining your green banks, do not fight them blindly every year. Diagnose your problems and then try to find answers that can help you and keep your membership happy. I have found that some of the intensive maintenance practices we have used for years on our greens and tees may have to be used to maintain other areas on the golf course. It has worked for me, and it can work for you.

PROPER TREE PRUNING

Elroy Limmer

Pruning at any stage of a tree's life will impact on its longevity. Therefore, it is imperative that you seek out the best and most up-to-date pruning practices available.

Trees need periodic pruning throughout their lifetime. Pruning and shaping at a young age is most important. Corrective pruning is often needed to reduce excess shade, prevent branches from rubbing against buildings, wires, other branches, pedestrians, or vehicles. The removal of double leaders or V-shaped crotches will reduce splitting trunks, broken branches, and the need for future cabling. This will also reduce future tree work costs.

Pruning should start as soon as the tree is planted. In the past it was common practice to remove one-third of the top growth when a tree was transplanted, resulting in the formation of a double leader. Today this is not recommended, and only corrective thining should be addressed.

Stubs should not be left when branches are cut. The tree cannot properly heal from such a wound, and the stub offers an entry point for decay organisms. Branches should never be cut flush with the trunk. Always prune just outside of the branch collar. A good way to check if a branch has been properly pruned is to check the wound a few months after pruning. New bark should be growing evenly around the wound. If new bark is not present at some point, it has been improperly pruned.

What happens if an improper cut is made? It will take longer to heal on the outside and bacteria will most likely cause wood rot. The wood rot bacteria enters the wound, and if the branch protection zone has been removed, the tree has no defense against the bacteria. Always avoid wounds of any kind because they are sites for bacteria. Be especially careful of lawn mower damage.

In the past, a predominant theory existed that any wound should be treated with a tree paint or wound dressing. This theory held that these methods would prevent bacteria from entering the wound, but extensive testing has proven this not to be the case. In fact, the paint or dressing may do more harm than good by causing moisture to be held behind it and creating ideal living conditions for wood rotting bacteria.

Topping or heading refers to the removal of a major portion of the crown by cutting branches to stubs. This causes severe physiological damage to the tree, resulting in more dieback and eventual death. If an arborist would suggest that a tree should be topped, his integrity is in doubt. Such an arborist either doesn't know what he is doing or doesn't want repeat business. Topping will cause the latent epicormic buds to emerge in large numbers, creating clusters of branches below the stub. The new branches have a poor attachment to the trunk, and they break off easily.

Elroy Limmer is Supervisor of Contract Services, Peoria Park District, Peoria, Illinois.

Natural Target Pruning

Prune Correctly

Correct pruning is the best thing you can do for your tree.

Here are the guidlines:

Natural target pruning*

1. Locate the branch bark ridge (BBR).
2. Find target A outside BBR.
3. Find target B where branch meets collar.
4. If B cannot be found, drop an imaginary line at AX. Angle XAC equals XAB.
5. Stub cut the branch.
6. Make final cut at line AB (with powersaws make final cut on upstroke).

Do not:

- make flush cuts behind the BBR
- leave living or dead stubs
- injure or remove the branch collar
- paint cuts

The best time to prune living branches is late in the dormant season or very early in spring before leaves form. Dead and dying branches can be pruned anytime. Use sharp tools! Make clean cuts. Be careful with all tools. **Safety first!**

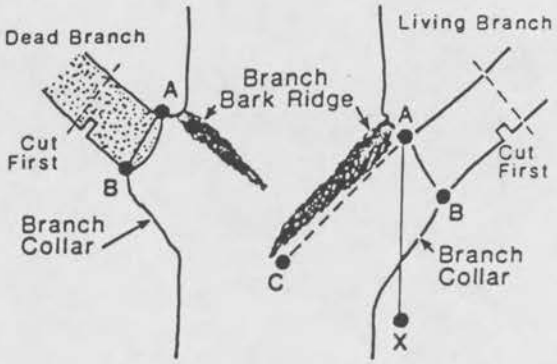
Topping

Topping trees is a serious injury regardless how it is done. Avoid it if possible by starting to prune early in the life of the tree to regulate its size and shape. If you must top cut, follow these guidelines:

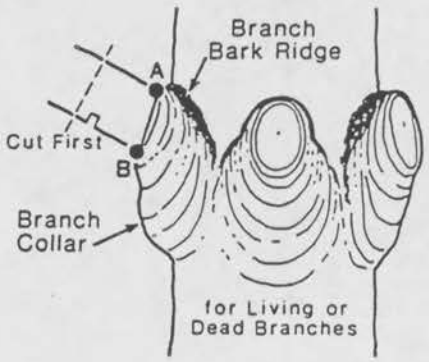
Cut line DE at an angle approximately the same angle as the angle of the BBR. Do not leave a stem stub. Do not paint the cut. Know your safety limits; call professionals when the job is too big for you.

*Information from Dr. Alex L. Shigo, plant pathologist, USDA Forest Service, Northeastern Forest Experiment Station, P.O. Box 640, Durham, New Hampshire 03824

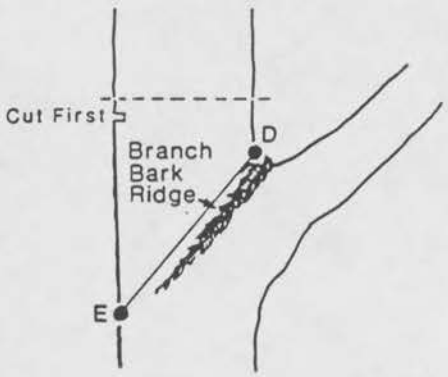
Hardwoods



Conifers



Topping



LOOKING BACK ON BENTGRASS CONVERSION

Roger A. Stewart

The process of converting fairways to bentgrass has become more and more popular in the past three years. This is true not only at private golf clubs but also at some daily fee operations as well. This is due, in most part, to the increasing desire of golfers to have the "tight lie" on fairway turf. Golf course superintendents have also come to the realization that creeping bentgrass can be managed in such a way as to insure it's persistance over less desirable *Poa annua*. We now know that this grass is much more tolerant of heat and drought than was previously acknowledged.

Looking back, some superintendents have done fairway conversion projects a little differently than the expected norm: the "expected norm" being the use of glyphosate on the fairway area and then overseeding by using a tractor-drawn slit seeder. The seeding process is usually done 5 to 7 days after the application of glyphosate. The seeding rate is approximately 1/2 pound of seed per thousand square feet, seeded diagonally in two directions, for a total seeding rate of 1 pound per thousand square feet. This process is normally started in late August and completed in early September to allow the new plants sufficient time to mature before winter.

A little twist to this process was put in by Brian Chalifoux, Golf Course Superintendent at Olympia Fields Country Club, Olympia Fields, Illinois. Brian did some experiments with the effect of glyphosate on the germation of creeping bentgrass seed and realized that he could reverse this process by seeding first and then applying glyphosate. The reason he did this was to help alleviate some of the problem of disruption caused by the seeding operation. Because of the two-directional diagonal slit seeding into a dead turf mat, there is no root system to hold that mat in place, and considerable disruption is usually evident during this procedure. This situation requires a great deal of corrective hand labor. Brian felt that seeding into living, healthy turf with a root system would help to alleviate some of this problem. The process he used began around the last part of August with 8 to 10 aerifications of the fairway area using a Ryan pull-type aerator. The cores were ground up and the area cleaned of remaining debris. Low areas and depressions around sprinkler heads, pipe, and drain tile were leveled. Seeding began around September 4. The fairways were seeded with Penneagle Creeping Bentgrass in two directions using a tractor-drawn slit seeder at a rate of 1/2 pound of seed per thousand square feet in each direction with an additional 1/2 pound of seed per thousand square feet applied using a drop spreader for a total of 1 1/2 pounds of seed per thousand square feet. It took about one week to finish the seeding process, and then the fairways were fertilized with 13-25-12 at a rate of 1 pound of nitrogen per thousand square feet. When all of this was completed, the glyphosate was applied at the recommended rate. An indicator was also used to insure proper coverage of the material. This process helped to dramatically reduce the labor after the seeding process. Brian believes an important part of this project was a second seeding operation around October 1 on those areas that were a little weak in germination.

Roger A. Stewart is Golf Course Superintendent, Riverside Golf Club, North Riverside, Illinios.

He felt this really helped to provide a uniform stand of turf the following spring. Brian feels his population of creeping bentgrass the following spring was approximately 60 to 70 percent. Needless to say this project was a tremendous success and has provided the members at Olympia Fields Country Club with excellent creeping bentgrass fairways.

Art Bensen, Golf Course Superintendent at Butterfield Country Club, Oakbrook, Illinois, had for some time wanted to level up depressions and undulations in fairways that were created when the fairways were constructed in 1927, before modern earth moving equipment was available. He saw the use of glyphosate in a fairway renovation program as a way to accomplish that and also rejuvenate the creeping bentgrass population in the fairways at the same time. Art began his project in mid-August by applying glyphosate, and after 5 days, began stripping two strips of sod from around the edge of each fairway while stripping off the sod of his decks in front of each green. Each irrigation head in the fairway was removed, followed by plugging the pipe and marking each location at the edge of the fairway with a stake and an "X" made in the turf with glyphosate. The next step was to contract a local excavator to come in with a road grader and loader to strip the remaining sod and haul it to some areas out of play on his course, to be used to create some berms and mounds. When this process was completed, he had contracted with Koelper Brothers Golf Course Construction Company to do the final grading and seeding. This process began by discing up the top 6 to 8 inches of soil. Then, using Lely "Turfshaper," the soil was pulverized, which began to level out the depressions and undulations. The next implement used was a "landplane" developed by Koelper Brothers. This consisted of a couple of steel "I" beams mounted on a frame with wheels for transport. The "I" beams are lowered to the ground and the unit is then drug around behind a tractor, grading the soil to fill the voids. The finish grading was accomplished with a device similar to a large sand trap rake pulled behind a tractor with a brush attachment. This was followed by a roller. This process of leveling and rolling was done several times to achieve the desired results. When the process was completed, Art enlisted Ken Killian, Golf Course Architect, to recontour the fairway edges before seeding began. The irrigation heads were then reinstalled and graded accordingly. Seeding was accomplished by using a Brillion seeder. The fairways were seeded with 50 percent Penneagle Creeping Bentgrass and 50 percent Seaside Creeping Bentgrass, at a rate of just under 1 pound of seed per thousand square feet. New rough areas created by the recontouring process were seeded with a Kentucky Bluegrass blend. After seeding was completed, all the areas were hydromulched by the Oakbrook Landscape Company.

Butterfield Country Club is a 27-hole facility; nine holes were completed this year, with the other two nines to be completed in the next two years. The cost of the project for nine holes was approximately $45,000. As with Olympia Fields County Club, Art feels this project was a complete success and is looking forward to the completion of the other two nines.

These processes are, indeed, variations of the original conversion programs and certainly have their advantages. All of us who have gone through any regrassing program know that this is only the start of the process for achieving great bentgrass fairways. The management of that turf, afterward, is what will determine the long-term success of the program. At Riverside Golf Club, we have completely changed our management program to enhance the growth of bentgrass. We have a five-part program that works very well. The first part consists of the conversion process. The second part involves reducing the irrigation to that

turf by as much as 70 percent. The third part is the reduction of the amount of nitrogen fertilizer used to less than 2 pound per year. The fourth part is the use of lightweight mowing equipment on fairways. The fifth and final part is intensive aerification of the fairway turf using Ryan Greensaires. The combination of all these parts will help to guarantee substantial bentgrass populations in the future. In conclusion, this process is definitely well worth the effort and would be done again if the need arises.

TAKE-ALL PATCH AND DISEASE UPDATE

Joseph M. Vargas, Jr.

There are a group of diseases that produce patches on desirable turfgrass species primarily by attacking the root system of the plants (Table 1). In the past this group of diseases was often mistakenly referred to as *Fusarium* blight. There are many other patch diseases of turf, but they primarily attack the foliage, crowns, rhizomes, and stolons.

Table 1. The Patch Disease, Casual Organism, and Primary Host

Disease	Organism	Primary Host
Summer patch	*Phialophora graminicola*	Annual bluegrass
Necrotic ring spot	*Leptosphaeria korrae*	Kentucky bluegrass
Take all patch	*Gaeumannomyces graminis*	Creeping bentgrass

SUMMER PATCH

It has become increasingly evident over the past few years that summer patch, caused by *Phialophora graminicola*, is a primary disease of annual bluegrass during warm weather. It can also be found on Kentucky bluegrass and fine-leaf fescues, but far less frequently.

On annual bluegrass, the initial symptoms are a yellowing of the turf in patches, usually six inches to a foot in diameter. This is followed by a thinning of the turf, with the remaining turf turning bronze in color. If warm weather persists, all the turf in the patch may die. Most of the creeping bentgrass cultivars are resistant and creeping bentgrass frequently can be seen recolonizing the centers of these patches.

Preliminary data indicate that soil temperature and soil moisture may be important in the development of this disease. Excessive irrigation during hot periods or absence of irrigation following the hot period may make the diseases more severe.

NECROTIC RING SPOT

It now appears that necrotic ring spot, caused by *Leptosphaeria korrae*, is the primary patch disease found on Kentucky bluegrass. The symptoms can be observed throughout the growing season, even though *L. korrae* appears to be most active during the cooler weather of the spring and fall. The plants that were infected by *L. korrae* in the cooler weather are in a weakened condition and are very susceptible to summer heat stress or drought stress. Subjecting the necrotic

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ring spot plants to either of these stresses will lead to the death of the weakened plants and the recurrence of symptoms, even though the pathogen may not be active at this time.

The initial symptoms are patches six inches to two feet in diameter, with straw and red-colored blades intermingled in the patch. Older patches may have green grass in their centers, with the straw and red-colored blades in the outer area of the ring, giving a frogeye appearance. When symptoms appear in the warm weather, the red blades are often scarce.

Nitrogen is important in the recovery of the patches caused by necrotic ring spot. Between three and five pounds of actual nitrogen/1,000 sq ft/season is necessary to promote recovery of necrotic ring spot patches. Proper cultural practices are also important in the recovery of the patches and for preventing new ones from developing. These include coring to relieve compaction and layers that result when sod of one soil type is laid on top of soil of another type, which is a very common practice during the establishment of home lawns and commercial lawn properties. This results in short rooting during the warm weather, when the roots of the turfgrass plant are confined to the upper layer. Coring and reincorporating the soil back into the thatch will, over a period of years, alleviate the layering problem. It will also help manage any potential thatch problem, which is important in managing necrotic ring spot, because thatch has a poor moisture holding capacity, and turfs growing in a thick thatch are more susceptible to drought stress.

Light, frequent irrigation is also important in managing this disease. The theory, that deep, infrequent irrigation is more beneficial to turf development, is just that, "a theory." Preliminary research data is indicating that light, frequent waterings may be more beneficial to the turf. The light, frequent waterings on a daily basis, around midday, have certainly been shown to help manage necrotic ring spot. The turf appears to be benefitting culturally from the cooling of the turf and biologically from the build-up of beneficial microoganisms in the moist thatch that may be antagonistic to *L. korrae*.

Lawn Restore, Green Magic, and Strengthen and Restore are products that appear to be supplying some biologic management of necrotic ring spot. These products contain antagonistic microorganisms (Lawn Restore) or their by-products (Green Magic and Strengthen and Restore). They have been effective in promoting the recovery of necrotic ring spot patches and preventing the development of new ones. The key word is "management." These products are not a one-shot cure, but, used systematically on a regular basis, they will manage this disease and provide a healthy turf. In addition to the antagonistic microorganisms and their by-products, these products contain the major and micronutrients necessary for a healthy turf.

TAKE-ALL PATCH

Take-all patch, caused by *Gaeumannomyces graminis* var. *avenae*, was formerly known as Ophiobolus patch, caused by *O. graminis*. This disease was originally thought to be confined to the Pacific Northwest. It has now been reported throughout the United States and Canada wherever creeping bentgrass is grown. Lowering the pH, through the use of sulfur, still appears to be the best way to manage this disease. A word of caution is necessary. The granular sulfur products have been observed to cause injury to the turf the season following application. This injury initially resembles dollar spot. The sprayable sulfurs are just as effective and do not have the bad side effects.

INSECT AND INSECTICIDE UPDATE

Roscoe Randell

INTRODUCTION

For the year 1985, insect activity in home lawns was less than average for most areas of the state. There was more concern with questionable insecticide performance than with severe insect populations and damage. This concern will continue into future years.

INSECTS

The usual insects appeared in the state with some visible damage resulting. Control applications were made and lawns recovered. Sod webworms caused brown areas in lawns in July, August, and even September in some areas. Many of the adult moths flying about in late summer were free of any disease; therefore, the 1986 population should survive the winter at a normal or above average population. Chinch bugs again appeared at each end of the state. The hairy chinch bug was a pest of bluegrass in Cook, DuPage, and some surrounding counties. The southern chinch bug attacked zoysiagrass in the southern one-third of the state. These bugs suck plant juices from grass plants in sunny and drought areas of lawns. Greenbugs migrated into the central section of the state in July. Many circular areas beneath trees appeared to be dying. The green plant lice could be found in the green border around the dying area. Some damaged areas were treated, but many were not, and most recovered by late August. Annual white grub activity had been reduced in 1983 and 1984 due to drought conditions during egg laying in July of each year. Adult beetles during July, 1985 were few, but the surplus moisture in many areas provided for excellent egg laying, and eventually slight to moderate grub damage occurred in early to mid-September. High, early fall temperatures, lack of soil moisture, and a grub population of 5 to 10 grubs per square foot brought sudden visible grub damage in a great many home lawns. This was true even in lawns with a preventive treatment application. Oftanol applied as a preventive treatment in June and July quite often failed to effectively control grubs, even at low to moderate populations. The sudden failure of Oftanol to provide consistent control over a 2- to 5-month period is not understood.

INSECTICIDES

Chemicals suggested for use to control turfgrass insects in 1985 included diazinon, Dursban, trichlorfon (Proxol or Dylox), Oftanol, Turcam, and Orthene. It was hoped that Triumph would receive federal label registration for 1985 but it did not.

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Oftanol was not consistent in performance. Diazinon is being reviewed by the Federal EPA because of its toxicity to waterfowl. For the past twenty-five or more years this chemical has been effective against certain insects with a moderate toxicity to the user. However, it has always exhibited a high rate of toxicity to geese and ducks.

A granular formulation of Proxol was used in grub control plots with good success. Turcam performed well in grub control tests as a 75-percent wettable powder as well as an experimental 35-percent concentrate.

SUMMARY

In 1986, the potential for annual grub increase in population is higher than in 1985. The climate and soil conditions in July will determine the success of egg laying. It is hoped that the problems with both Oftanol and diazinon will be solved and both will be available in 1986 for turfgrass insect control.

INSURANCE FOR THE LAWN CARE INDUSTRY

Richard Hoffman and Barb Rocos

No one is escaping the dramatic changes in the insurance industry. Underwriting losses in the past few years have been staggering. Other business expenses have continued to rise. The cushion afforded by investment income is finally exhausted.

In the good old days, not too many years ago, there was a lot of competition in the insurance field. Many insurance companies were diversifing and writing insurance coverage for businesses that had little or no knowledge or expertise. Premium rates were used as a means to buy business. In those days, it was all good and well. If premium rates were too low, they could make up the difference with good investments and high interest rates. The interest rates are now declining and rates are being increased to cover the cost of claims being incurred. The days of being able to shave something off the premium rates in order to get the business are over. Many insurance companies are pulling out of the markets that, a few years ago, they thought would be profitable to get into.

Re-insurance companies are also playing a major role in the current insurance crisis. Lloyds of London carries better than 80 percent of all re-insurance in the United States. Lloyds reports their profit/loss statements yearly. These reports are prepared and published three years behind current time. This is done to give them a more accurate picture of the financial situation of the company. After three years it is assumed that most claims have been reported and settled. Those claims that are not actually settled will have been worked enough, giving some idea as to the amount of money needed to close the claim. In 1984 Lloyds of London gave their financial report for the year 1980. In 1980, Lloyds reported losses in the hundreds of millions of dollars. The frightful realization of this is that the report was for the losses experienced in 1980. As we are all aware, these past few years have also shown some devastating losses world-wide.

How does this affect the turf manager? The answer, unfortunately, is "right in the pocketbook." Insurance companies cannot exist without the re-insurance companies: re-insurance companies carry the excess coverages that the companies, which insure your business, cannot afford to handle. In the event of a catastrophic loss, much of the claim is paid by the re-insurance company. The insurance prices charged are directly linked to the losses sustained worldwide. The tremendous losses of the giant corporations are passed right down the line to each consumer.

There are other factors that are just now being realized for the serious proportions they hold. One of the major problems industry-wide is the pollution issue. This problem has caused panic. In the turfgrass industry, the products that are used are of a diluted nature, and they do not fall into the category of a

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pollutant. Or do they? Was pollution a problem fifteen years ago? Will this be an issue in the turfgrass industry in fifteen years? There is not enough money in the entire insurance industry to pay the claims that have arose or could arise as a result of court interpretations of pollution coverage and the claims involved.

Other problems that we face include that of liability and workmen's compensation claims. In 1940, 35,000 civil cases were filed in federal courts. In 1982, the number of cases filed increased to 206,000. State court filings have reached an unprecedented level of 12 million: the average of one lawsuit for every 13 adults. The trends in court decisions tend to lean toward compensating the victim. The general attitude of our society is that anybody who has suffered any harm should collect from someone, even sometimes when they just believe that they have suffered, or if they think that they will suffer in the future. Where and when will this all stop? Efforts are being made to put limits in the judgments that can be awarded, but this may never happen.

Workmen's compensation laws are controlled and benefits are determined by state laws. Changes in the benefits payable to injured employees are being looked at, but what will be done? There are many companies that are unable to obtain workmen's compensation insurance coverage and are being placed through insurance pools. Currently, discussions are taking place with the possibility of the state taking over workmen's compensation entirely. In three states, complete state control of workmen's compensation insurance already exists.

Insurance companies pay for these large court awards and some workmen's compensation claims for many years. For example, consider the case of payment for a death claim or serious injury. Benefits are paid out at times for the life of the injured party. In other cases payments are made for years to the widow or minor children. There are cases where these claims are being paid out long after insurance companies stop receiving money in the form of premium payments. This would happen in the event that the company that was insured at the time of loss is no longer in business or has changed insurance carriers. How long could a turfgrass manager survive in business if he was applying chemicals or fertilizer to lawns for years and years and not being paid for it?

Who pays for all the large court decisions and the workmen's compensation claims that are decided by the Industrial Commission? The insured and the insurance companies, in the form of increased premium costs, pay for these decisions.

The picture looks pretty bleak. Losses continue to rise in alarming proportions. Law suits are settled with huge awards. Where will it end? This speech was not intended to place a blanket of doom over the issue. It was intended to give you some background on just a few of the many problems that the insurance industry faces.

How can this all be turned around? Every consumer must become involved: not just the lawn care industry, but every large company and every small business in the country. Safety must be stressed in every business. The disasters of nature cannot be stopped, but what can be done to prevent a claim or lessen the exposures of claims that do happen?

The importance of safety should be stressed to a company's employees. They should receive the training that they need, being reminded of what they have been taught. The driving records of the employees that drive company vehicles can

provide helpful information. These vehicles should be on a regular maintenance schedule. Fire extinguishers in company vehicles are important, as well.

Some insurance companies hold safety training meetings for employees of the insured. They can provide fleet safety checks. The local fire department should be made aware of the buildings in which chemicals are stored.

One should make every attempt to control theft. The facility should be properly lighted at night and burglar alarms should be installed, and products secured in an area that makes it difficult for a thief to get into.

The lessons of safety and claims awareness have to be stressed by all turf managers. The only way to bring insurance costs down are to bring the claims down. Consumers pay for the claims that are experienced all over the United States.

The following are a few of the items that could possibly reduce the cost of insurance coverage.

Deductibles are the first item that should be considered in every line of coverage. Be sure to check the savings in going to higher deductibles.

The rates for workmen's compensation are regulated by the state. There are many catagories for the classifications of payroll. Be sure to use the right classifications for all employees, sales, research, clerical, and the like. If an unusual amount of workmen's compensation claims occur, consider their cause. When individuals are considered for employment, think about their history of workmen's compensation claims.

With regard to property insurance, when was the last time the buildings were appraised? Is too much insurance or not enough insurance being carried? When warehouse space is leased, in most cases it is less expensive to insure stock in a brick or concrete building than it is in a frame building.

Consider the employees driving records when assigning duties. Insurance companies check driving records for each insured consumer. Make sure enough liability insurance is carried to protect your business in the event of a major claim or lawsuit.

When a policy comes up for renewal, you should contact all the carriers that are willing to provide coverage and then compare cost and coverages. For example, coverage for debris removal can be provided, which would include chemical spills and the removal of debris from a covered peril, such as a fire. Coverage for accounts receivable is also available, which allows the insured to collect if, for example, a fire destroyed the records. Tank leakage insurance for sudden and accidental leakage of your liquid products is another type of available coverage.

PATCH DISEASES: IDENTIFICATION AND CONTROL

Robert C. Avenius

INTRODUCTION

The following is a summary of the latest information on the identification and control of patch diseases. The four patch diseases that will be discussed are yellow patch, brown patch, necrotic ring spot (NRS), and summer patch (SP).

When dealing with patch diseases many questions and problems arise. The primary question is identification. There is a good reason for this because in the field, these diseases all look alike. Currently, it seems that everything that looks like a frogeye is called *Fusarium* blight. In reality there are differences between these diseases, but they are subtle.

The four diseases will be discussed from the standpoint of the home lawn situation, with the following questions being addressed:

1. How can the various patch diseases be differentiated?

2. What control measures can be used?

In many cases, the solution to the problem is not always easy and often, the best long-term answer is to reseed the area in the fall with resistant varieties. One of the easiest ways to tell these patch diseases apart is to categorize them according to:

1. Time of occurrence

2. Environmental conditions

3. Pathogen identification

4. Symptom expression of host

Lets break these four patch diseases into two groups: yellow patch and brown patch. The reason for this separation is that they are both caused by *Rhizoctonia* fungi.

YELLOW PATCH

Yellow patch is a relatively new disease compared to brown patch and is usually found on Kentucky bluegrass. It occurs in the spring or fall of the year during cool, wet conditions. The optimal temperature range is from 50 to 70°F.

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In many cases it occurs on sodded bluegrass that is not fully established (3 years or less) and can occur on only certain sod pieces. The symptoms are the appearance of circular patches 2 to 18 inches in size that are light tan or brown in color. They are very similar to NRS or SP in appearance. Healthy grass in the center is surrounded by brown, depressed areas which may not recover.

Lesions can be found on leaves, appearing bleached in color and having dark, irregular shaped borders. Another symptom is that reddening of the leaf blades may occur. Its difficult to tell if this is due to the disease or just secondary symptoms.

Positive identification can be quite easily made by sending a sample to a diagnostic lab. Furthermore, in the lab, yellow patch can be easily distinguished from brown patch.

Control of yellow patch has revolved around seeding such areas with resistant varieties. Fungicides have proven to be useful in some cases, but the majority of the time they are inconsistent and have not given the desired results. The fungicides most often recommended have been Chipco 26019 and Daconil 2787.

BROWN PATCH

This disease is a common problem on all cool season turfgrasses and occurs when temperatures are 80 to 85°F and humidity is high (hot, humid conditions).

The earliest symptoms can be described as patches or rings of blighted grass that are light green or yellowish in color. These areas will turn brown as the margin advances. Lesions can sometimes be found on the leaf tissue. They are more commonly found on tall fescue than on Kentucky bluegrass. Lesions are brown and surrounded by a irregular-shaped border.

Examination of the stem often reveals small black sclerotia or resting bodies of the fungus. These can be seen with a handlens but could be difficult to tell from soil particles if you are not familiar with them.

Control suggestions for brown patch revolve around reducing the nitrogen applied prior to warm weather and avoiding frequent light watering of the turf. Many times the crown is still alive and turf will recover which is unlike SP or NRS.

In severe cases, there are several fungicides available for the control of brown patch. The most important factor in any application is to apply the fungicide at the right time, when temperatures are 70°F or above, and daytime temperatures are 80°F or higher and the humidity is high.

NECROTIC RING SPOT AND SUMMER PATCH

Fusarium blight syndrome is caused by at least two different fungi. What used to be called *Fusarium* blight syndrome is now called summer patch and necrotic ring spot. Summer patch is caused by *Phialophora graminicola* and necrotic ring spot is caused by *Leptospohaeria korrae*. These symptoms are quite common during hot, dry weather. They form rings, streaks, or crescent shapes. Many times the

classic frogeye pattern is present. These diseases are created by the presence of the two fungi and environmental stress. The combination is needed for disease to occur.

The fungi are soil-borne pathogens, which means they infect the rhizomes, stolons, crowns, and roots. They basically clog or damage the root system of the turf plant. The fungi penetrate through the cortex and endodermis and into the vascular tissue of the roots, blocking off the xylem tissue. The fungi are growing on the root systems in the spring, but symptoms may not appear till the summer. The disease is well advanced before symptoms occur. Lesions will not occur or be found on the foliage like in yellow patch or brown patch.

The best way to control these diseases is to use resistant varieties such as ryegrass, tall fescue, or resistant bluegrasses. The term "resistant" varieties does not mean the turf is immune, just tolerant.

In the past, control through the use of fungicides has been inconsistent due to improper timing of application and failure of the fungicide. In the field, it is not possible to positively identify which disease is causing the problem and thus, fungicides that are effective on both diseases must be used. Examples of these fungicides are Banner, Rubigan, and Tersan 1991. The fungicides should be applied one month before symptoms develop. This will help keep root systems alive and prevent symptom development during the stress periods of summer. Fungicide application may have to be repeated if weather dictates.

SUMMARY

Yellow patch is a cool season disease which occurs in the spring or fall. Roots are not damaged as in NRS or SP.

Brown patch is a hot, humid weather disease. Lesions are present on the leaves. Lab diagnosis can be used to differentiate between this disease and other patch diseases.

NRS and SP are root pathogens which destroy root systems, and the best long-term control is to overseed with resistant varieties. Fungicide control should be applied before symptoms become apparent or active.

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INTRODUCTORY AND WELCOME REMARKS

Thomas Oakley

Jim Farrell, the USGA Regional Affairs Manager, asked me to welcome you to the USGA Regional Seminar session this morning. When he asked me, we were still playing golf, and it was very much on everyone's mind. After the weather most of us have had the last month or two, golf is a long way from anyone's mind--unless he is in the golf business. I don't remember a worse fall following a great summer. Over the last week or so, we see our farmer friends out trying to get in the last of what once was a great crop--boy, I don't envy them. Fortunately, most of us also had "a great crop" for our golfers to play on.

Anyway, when Jim asked me to open this session, I wondered what approach he wanted me to take with a group that clearly knows turfgrass, what the USGA does, and what the Turf Advisory Service is.

He suggested that I try to put into perspective our subject matter here today--turf--with what it means to the average golfer who plays our courses. To do that, let me offer a definition for our job--"To maintain and to improve playing conditions." Maybe this is a little too simple, but that's what it is as far as the golfer is concerned.

How does he judge your golf course? How green it is? Yes, and what else? How long the rough is--how fast the greens are--the layout--where the pins are--tree location--how they are trimmed--tee beautification--how the ball lies on the fairway and a lot more things also.

Does everybody like the same thing? It doesn't seem like it.

Obviously, the superintendent doesn't control all of the above items, so what can we do?

We have to deal with the greens chairman and his committee, the club president and the board, individual golfers (both high and low handicap ones), all of whom are vocal and sometimes a little misinformed and maybe even get a little unreasonable once in a while.

So, what do we do? What compromises are we willing to make to keep the membership happy? Well, we all know I'm spinning an old scenario and all of us involved in the golf course have to take some heat.

I have been a greens chairman, a USGA committee member on the green section committee, on the club board and a club president, and I have taken my share of the heat from all sides. Is it worth it? I think the answer is "yes" because this is the process, as imperfect as it is, through which golf courses have gotten better and better over the years.

Thomas Oakley, USGA Green Section Committee, Quincy, Illinois

Think back; remember the golf course you played when you were a kid? My, how it's changed! The technology has changed, our equipment is better, most of us have a lot more money to spend per hole, we are better managers, but perhaps most important, a great deal of research has been done on turfgrass and is paying off.

The USGA will have spent $1,279,600 on research in the 3 years from 1983 through 1986. This is on top of the millions on research that have been spent by the USGA Green Section since 1920, not to mention the research work that has been done across the country by the schools of agronomy and, of course, last but not least, the research work that has been done by the associations like the Illinois Turfgrass Foundation. What has happened over the years is that we have all committed a large portion of our resources to improve the grass we play golf on, and it has worked and will go on working as we continue to upgrade the expectations of the golfer.

As a practical matter, I want to make a pitch for the USGA Turf Advisory Service. Each year I write a lot of letters encouraging club presidents and superintendents to consider this service. For those of you who use it, you know why. I write these letters with the true conviction that there is no money that can be better spent than to bring a knowledgable, hard working USGA professional, who sees hundreds of golf courses each year, to your club to assist in the evaluation of programs, the analysis of problems, and the development of future plans. I have seen how well this works many times, and from that background, the USGA Turf Service would be my number one priority, regardless if I were on the club committee or if I were the superintendent.

This USGA representative has an outstanding background both in terms of education and experience. In many cases, he has been a superintendent or perhaps his father has been. He can evaluate without putting anyone on the spot, he can articulate the problems the superintendent faces with an objective perspective, and he can help the club get the most for its money by making recommendations based on what many clubs are doing or have done. The reports following the visits give a great road map to follow, and I have never seen a superintendent put into a bad light in one of these reports. Many times I have seen just the opposite with the USGA, confirming what the superintendent has said when the committee was not in support or would not fund a project.

The USGA Turf Service is so good a third party evaluation for what has happened that I don't believe a club should do without them. It's good to have Jim Latham back. I'm hearing great things about his first year back on the road.

In closing, I want to say that, from the average golfer's standpoint, we all like to know what is going on and why. Good communication with the golfing membership is important, and anything you can do to make the golfer aware of what you are doing and why, the better they can appreciate your efforts even if they do not always totally agree with the project. Many clubs give the superintendent space in the monthly bulletin to keep the members up to date. Kurt Erdman at the Rochester Golf and Country Club, Rochester, Minnesota, has a column and many times reprints sections out of the USGA Turf Service Report. With 40,000 pine trees and 5,000 elms, Kurt needs to be a forester as well as an agronomist.

I want to thank you for these few minutes to talk about something I love--golf and golf courses--and I hope all of you have great greens next year, but don't have them too fast and don't put the pin too near the edge of the green.

Lightweight Mowing: The Rest of the Story

James M. Latham

Fairway mowing practices have come a long way since single unit putting green mowers were used on narrow approaches to greens in the early 1960's. One of the first superintendents to do this was Nelson Monacle at Portage Country Club in Akron, Ohio. At Portage Country Club, bunkers shielded some greens to the extent that the approaches were almost too narrow to navigate pull-behind gang mowers. Mr. Monacle simply continued the collar mowing height outward to the front of the bunkers, giving the fairway mowers a broad turning radius and eliminating the poor playing condition immediately in front of the greens. This has evolved, today, into widespread use of lightweight, self-propelled 3- and 5-unit mowers. In the regions where cool season grasses predominate on fairways, their use has encouraged the spread of bentgrass into areas long since colonized by *Poa annua*. The speed of this takeover action is amazing, far exceeding any expectation.

The credit for this sudden dominance has been given to reduced soil compaction and the collection of clippings as practiced by many golf course superintendents. Weight reduction is not merely using lighter-weight machines, but in the pounds per square inch of the load bearing tires and mowing units exerted on the turf surface. It is incredible that this, in itself, allows soil to "de-compact" in a short period of time. Recent research in agriculture has shown that simple freeze-thaw cycles in winter do little to benefit soil structure.[a]

The collection of clippings may help reduce the amount of viable *Poa annua* seeds returned to the soil for future infestations. Clipping removal may also lessen the "mulching" effect they have in maintaining high humidity in the microclimate where the turf is growing, since the ideal habitat for disease development is disrupted to a degree.

Perhaps all three of these phenomena have a cumulative effect in helping bentgrass growth to be adequately aggressive in invading *Poa annua* colonies. It is difficult to believe, however, that such rapid, radical population changes can be credited to these actions alone. After all, *Poa annua* is subject to the same disease stresses as bentgrass, so reduction of the clipping mulch is beneficial to both species. If the *Poa annua* density is high and the bent density is high, seed removal is not of immediate value.

When bentgrass growth so rapidly invades *Poa annua*, it appears to achieve canopy dominance. The lightweight mowers "float" on the turf. This allows the

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[a]Dickey, Elbert C., Peterson, Thomas R., Eisenhauer, Dean E., and Jasa, Paul J. Soil Compaction I--Where, how bad, a problem; *Crops and Soils*, August-September, 1985.

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lateral spread of bentgrass stolons to grow over the top of the more soil-bound *Poa annua* so that the takeover is from the top downward. The roots formed at the stolon's nodes are quite functional in the surface thatch and as long as it is moist, the bentgrass stolons grow normally.

There are disadvantages to the use of lightweight mowers. As the floating mowers ride *over* this growth, rather than *through* it as the heavier gang mowers did, fluffy turf growth with the subsequent thatch development is inevitable. Further, because most of the bentgrass roots are above the soil surface, the stress resistance of the turf is reduced. The lightweight mowers present the opportunity to achieve a long-sought goal, but a price must be paid.

The price is large area thatch management, through close irrigation control, thoughtful fertilization, and *cultivation*. The most important part, from the start, is cultivation. Mechanical dethatching as we know it today is not yet a viable alternative on twenty-five acres or more of fairway turf. Cultivation, as valuable as it is, is impractical in many golf operations, so preventive thatch management rather than curative renovation is the most sensible alternative.

Turf cultivation means the use of aeration machinery. Core cultivation and dispersal are currently the most programmable thatch management operations. The machines vary widely, but core aeration is the goal. It accomplishes two important things. First, it creates a hole in the compacted soil surface which allows roots to grow downward into the soil. Perhaps more important, it provides a means for oxygen to enter the root zone. A root system cannot develop without it. Compacted soils reduce root growth because of inadequate air space, not excessive water.

The second benefit of core aeration is bringing soil to the surface which is usually rich in organisms capable of decomposing the thatch. Most of the microorganisms in natural soils subsist on dead things--plants and animals--both macroscopic and microscopic. When intermixed with the dead leaves, stems, and roots in the turf, they can thrive if other conditions are right.

The other conditions, incidentally, include moderate moisture and a near neutral pH level. The microorganisms cannot grow under totally dry conditions, but should not be soaking wet, either. Decomposition of organic matter generates some weak acids, so light liming may be a great help in some instances. When in doubt, check the pH of the thatch layer. An old practice is to apply hydrated lime sparingly. This has nothing to do with changing the soil pH, just ameliorating the growing medium of the decomposition organisms. Thatch management is *not* aided by sulfur applications except, perhaps, under highly alkaline circumstances.

Core aeration is not the best-loved turf management practice on any golf course--by either the players or the maintenance staff. It is therefore a great deal easier for all concerned to begin a thatch management program early on when large equipment that is frequently used will do an adequate job. Equipment sized for greens undoubtedly does a more thorough job, but it is very time consuming and requires several machines to accomplish the desired end. These add up to a very high cost which might be averted by preventive use of properly sized equipment.

Most fairway aeration machines do not have enough tines to cut enough cores with one pass over the area. But there's nothing wrong with going over a fairway several times--perhaps four--if the turf is adequately rooted. Poorly rooted areas may require a different regime or the initial use of green-size machines until deeper roots are developed.

Core breakup and trash removal are constant problems associated with core aeration. Dragging with chain harrows, steel dormats, or pieces of chainlink fencing has been the standard procedure used for breaking up the cores and dispersing the soil. Timing is critical on heavy soils, because if the cores are too wet, breakup is poor and a lot of mud is dragged around. If the cores become too dry, they can't be broken up by drags. Some superintendents now use the verticut units in triplex putting green mowers for core breakup, after removing some of the blades. Others use an adaptation of large hammerknife mowers to do the job. Choice of equipment depends largely on the smoothness of the terrain.

The trash remaining on the surface must also be dealt with. Leaf sweepers and vacuums seem to do the best job, although some superintendents simply blow the material into the rough. The former seems to be the best overall.

A total program also must include turf recovery and prevention of weed establishment. Recovery should be initiated before the damage is done. Fertilizer should be applied a week or two prior to aeration so that all grasses are growing vigorously and their top growth *and* root growth are not inhibited. All that soil brought to the surface will provide escape for any number and type of undesirable seeds. They will certainly make the best of the opportunity, unless controlled by preemergence herbicides. Their application should immediately follow the cleanup operation.

Other post-aeration opportunists are cutworms and other insects. The holes are delightfully adapted as daytime hiding places. If their presence is anticipated, the proper insecticides should be used. A *proper* insecticide is one that will control the surface or root feeders selectively while not seriously affecting the earthworm population. These wonderful animals are the best thatch controllers, topdressers, and soil aerators we have, even though their castings are a problem in closely cut turf.

These comments are made not to discourage lightweight mowing of fairways to help bentgrass encroachment into *Poa annua* turf. They are simply a reminder that bentgrass requires a careful preventive maintenance to provide the high quality playing conditions that are expected of it. Curative treatment of heavily thatched bentgrass turf is much more labor intensive.

Bentgrass is preferred to *Poa annua* because of its ability to withstand a wider range of environmental stress, especially that which occurs during the golfing season. In general, bentgrass is more resistant to heat, drought, disease and salinity than annual bluegrass. It is also more cold tolerant. The playing qualities of the two species are quite similar when both are well maintained and in a vegetative mode of growth. Simply put, bentgrass is more dependable than *Poa annua*, even though it demands more stringent maintenance practices.

BUNKERS FOR GOLF I: THE GOLFER'S PERSPECTIVE

Roger E. Null

To quote the USGA rule book:

> A "bunker" is a *hazard* consisting of a prepared area of ground, often a hollow from which turf or soil has been removed and replaced with sand or the like.

I believe the key word in this definition is *hazard*. Most golfers have a mistaken view of the real object of a hazard. The majority of them simply look upon a hazard as a means of punishing a bad shot, when the real object of a hazard is to make the game more interesting: the successful negotiation of a bunker is a source of pleasure to all classes of players. There are many factors that affect a golfer's viewpoint towards bunkers.

BUNKER DESIGN

The design of bunkers has exceptional bearing on the playability of a golf course. The size, shape, and types of bunkers on a golf course are only limited by the artistry and the imagination of the architect. The manner in which the architect deals with these bunkers can either peak the golfer's interest or cause disenchantment with the golf course.

Alister MacKenzie, the great architect of Augusta National, Cypress Point, and many other great courses, stated it this way:

> The excellence of design is more *felt* than fully realized by the player, but nevertheless it is constantly excercising a subconscious influence upon him, and in the course of time he grows to admire such a course as all works of beauty are eventually felt and admired.

BUNKER PLACEMENT

Bunker placement is an extremely controversial and argumentative point. One of the objectives in placing bunkers is to give the player as much pleasurable excitement as possible. I feel no hazard is unfair wherever it is placed, and this applies particularly if the hazard is visible: it should be obvious that if a player sees a hazard in front of him and promptly hits his ball into it, he has chosen the wrong spot. A bunker placed in the exact position where a player would naturally go is *frequently* the most interesting situation because a special effort is needed to get over or avoid it.

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Bunkers should always be placed with a purpose in mind and none should be made which has not some influence on the line of play to the hole. Few bunkers are of any interest which are placed outside a direct line of vision. This line of vision only extends about 10 to 20 yards on either side of the direct line of play. Any bunkers placed outside this limit are usually of little interest and are more a source of irritation.

FAIRWAY BUNKERS

There is a philosophy that fairway bunkers should be large enough and shallow enough so a golfer can play whatever type of shot is required to reach the green. I disagree with this. I tend to feel more that a variety in styles of bunkers can be used for fairways, and that if the golfer does not avoid them with his shot, he should be prepared to deal with the consequences.

GREENSIDE BUNKERS

In my opinion, many greenside bunkers are placed too far away from the green that they are intended to guard. Greenside bunkers should be placed on or near the edge of greens; then, the player who is wide of them has an extremely difficult pitch and is frequently worse off then the man who is in them.

A bunker eating into a green is by far the most equitable way of giving a golfer full advantage for accurate play: it not only penalizes the man who is in it, but everyone who is wide of it. Many golfers share the viewpoint that greenside bunkers should be placed far enough away as to allow larger maintenance equipment the room to work: some as far away as to allow gang mowers between green and bunker. I feel any bunker placed far enough away from the green to allow gang mowers to pass is, without question, misplaced.

BLIND BUNKERS

Blind bunkers will be tolerated if kept at a minimum, or if they are used to serve a purpose other than as a hazard; such as stopping balls from rolling into unplayable lies, out of bounds, or into a lost ball situation. There are, of course, exceptions to all rules, such as those of "the Old Course" at St. Andrews. Most of the bunkers at St. Andrews are not visible from the tee or fairway. But golfers know this from the onset, so unless they have local knowledge of the course, it is wise for them to take a caddy to negotiate these bunkers. This also is a part of the design and charm of "the Old Course."

BUNKERS LIPS AND EDGES

The various styles of bunker lips and edges will be dictated by the golf course design. The only real concern of the golfer is that these lips and edges be clearly defined. It presents a very difficult situation when a ball lies in an area where the golfer cannot determine if he is in or out of the bunker. Since a sand bunker is a hazard, can he or can't he ground his club, can he remove loose impediments, and in which way is he going to play the shot. There are many situations where it is difficult to keep a well defined edge, especially with today's mechanical rakes causing much of the problem, along with crew

negligence. Nonetheless, this is a very important obligation of the superintendent.

BUNKER DRAINAGE

Another difficult situation for the golfer is to find his ball in a bunker that is full of water, while knowing that in order to get casual water relief, he must drop his ball inside the confines of the hazard: which means the ball will more than likely plug in the wet sand, causing a near impossible shot. Or worse yet, if the bunker is completely full of water, he will have to take a penalty shot in order to get relief outside the bunker. So bunker drainage is of the utmost importance to the golfer. In fact, a golfer is more concerned with the drainage of bunkers than with the drainage of fairways because in the fairway, he will always get free relief from casual water.

PLAYABILITY OF BUNKER SAND

There is a wide variety of sizes and textures of sands. Actual specifications and recommendations for these sands will be discussed in a later talk, but from a golfer's viewpoint, I like sands that are medium in size and texture. Also, the sand should not be too deep; this will give a firm feel but not be too heavy to blast through. This also provides the fewest number of plugged lies.

BUNKER MAINTENANCE

The degree to which bunkers are maintained is usually determined by the standards set by club policy, the green committee, or tradition. I think it would be the consensus of most golfers that the higher the standard of maintenance, the easier from which to play the bunkers. The main concern of the golfer is that, whatever degree of maintenance used, it be consistant throughout the golf course. I have far less problem with maintenance of bunkers by the maintenance staff than with the maintenance of bunkers by other golfers.

If the superintendent and his staff are expected to keep the bunkers raked and maintained on a regular basis, I believe the golfer should be *equally* obligated to maintain the bunker when he uses it. It is very irritating for a golfer to hit a shot into a maintained bunker expecting, at least, to find his ball in a raked lie only to find it nearly unplayable in someone's footprint. It is equally irritating for a conscientious golfer to play out of a bunker and then not be able to find a rake to repair the damage.

But, of course, there is another philosophy to the maintenance of sand bunkers. An article written by Peter Thompson, the five-time British Open champion and current leading money winner on the senior tour presents his philosopy in an article entitled, "Why Rake the Bunkers?":

> In golf, as in big game shooting, you have to be prepared to shoot your way out of the trouble you shoot your way into. This is part of the real fun. It tests a man's nerve, keeps him honest, shows his character.

Brave men will tackle their trouble shots with courage and resourcefulness. The coward will take all kinds of detours to avoid it in the first place, but once in it he will quiver in his shoes. All the more reason, therefore, to lament the passing of the ancient sand bunker, and to deplore the way they carefully prepare the traps nowadays in order to make escape easier. If I had my way bunkers would be *real* hazards, a holy terror to get caught in and a frightening experience to get out of.

Now take the modern situation, even at the time of championships when you would think that sand bunkers would be at their most ferocious, for after all, the champions are supposed to have the most resources. What happens? As often as not they have a man standing by in a white coat and a rake in his hand, ready to smooth out any irregularities that might be left behind by a victim in his efforts to escape. The sand has to be restored to perfection, not a ripple like a Japanese courtyard.

Now I ask you, where's the sense in that? Why prepare the hazard? Do they prepare the rough? Is here a man in white coat standing by in the rough to smooth out the grass before you get there? Or is there even someone on the fairway, ready to restore the divot marks in case some hapless follower get a bad lie? No there isn't. But they rake the bunkers. The see to it that there are no bad lies in the sand. They make them shallower too. And heap the sand up against the wall so that you can always get a straight shot in the pin.

The professionals are the first and worst complainers if sand bunkers present anything extraordinary in the way of punishment. Sand play is popularly presented as an art, incorporating a mystique that befuddles the less competent. In truth it's as simple as pulling rabbits out of a hat to the professionally initiated. That is, if the trap is smoothed and prepared. If it's not, there is invariably a raising of under-collar temperature, and a black look in the direction of the greenkeeping staff.

If I may make a prediction, it is that championships of the future will be played on courses where the sand is not raked and smoothed, but left untidy, foot-marked, weed-ridden, windblown, cavernous,and horrifyingly hazardous. Then we'll see the real fun. We'll see the champions become terror-striken at the prospect of getting caught, mind-tested in the process of getting out and altogether forced to display their propensity for greatness. Of course, it will never happen to you or me. We'll never get in them. We'll avoid them like the plague.

Thompson's philosophy is very interesting, to say the least. I think what the article exemplifies is that bunkers are a very subjective topic and that every golfer has his own idea of how bunkers should play. Because of this subjectivity and the varied opinions, there is only one real criteria which a golfer can require consistency.

Whatever bunker design, bunker placement, type of sand, or standard of maintenance one chooses, it should be consistent throughout the golf course, so that when a golfer begins a round, he will know exactly what to expect throughout that round. It is our obligation, as superintendents, architects, pros, officials, and golfers, to maintain that consistency.

BUNKERS FOR GOLF II: AN ARCHITECT'S PERSPECTIVE

Robert M. Lohmann

One of golf's greatest attractions is that it is played on natural terrain, or failing that, on terrain that has been molded so it has the aspect and feel of natural terrain. It is generally agreed that the best land for golf resembles the gently rolling terrain of the British linksland on which the game slowly developed and reached its first stage of maturity.

At St. Andrews, historians say the layout is completely natural and untouched by man, transformed by evolution into its present state. The bunkers at St. Andrews, as well as all the linkland courses, became an integral of part golf. As architect Geoff Cornish put it, "It is not surprising that a bunkerless course is seldom if ever a true test. It is comparable to playing tennis with the net set too low."

The old course's influence on generations of golf architects has been unequaled. It served as a model for early architects who, in their days, did little more than site eighteen teeing grounds and greens on the splendid golfing ground that was put at their disposal. Natures handiwork started the sandy depressions, which were probably enlarged by sheep sheltering from the wind. St. Andrews became and still is one long fairway with nine holes out to a distant point and nine holes back.

When golf spread inland,natural hazards did not occur with the same frequency as they did on links courses. After the routing plan for a new course was decided upon, the placing of bunkers became the next consideration. Bunkers are used for a variety of reasons. As a hazard, they are incorporated into the hole design for the purpose of penalizing a misdirected shot and for establishing strategy and shot values. Bunkers are popular hazards because they provide a reasonable chance for escape. With water, a penalty stroke must be taken. Heavy woods or deep thick grasses force the golfer to either play laterally or take an unplayable lie which is also a one-stroke penalty. A golfer playing from a sand bunker has a chance to recover without losing a stroke, depending upon his skill.

Bunkers are placed at the turning point of a fairway where no natural defense occurs. This forces the golfer to play the hole honestly. The closer he skirts the edge of the bunker with his tee shot while still remaining in the fairway, the better his advantage for the next shot. Golf shots played safely away from the bunkers demand a longer second shot, often needing to be played over hazards adjacent to the green or second target area.

Sand bunkers are used to provide direction and definition of the target area, be it a fairway or a green. Bunkers placed on the far side of the fairway visually turn the fairway at the target area and provide a direction line for the golfer off the tee. Placing sand bunkers around the putting surface defines and

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highlights the target. Bunkers are often used to catch errant shots from going out of bounds or into an unplayable situation. Using bunkers in this way will aid the golfer as well as speed up his play.

Regardless of design, bunkers are needed for aesthetics. The contrast of sand against grass and water,or the shadows provided by a deep grass bunker, add to the beauty of a golf course. The beauty of a well-maintained series of sand bunkers is remembered and talked about by the golfer. These conversations are a form of free advertising for the golf course. A course entirely devoid of bunkers lacks the visual definition which is important in developing the character of a golf course.

Bunker design and construction have many variations. "Pot bunkers, pit bunkers, cross bunkers, grass-faced bunkers, and flash bunkers" are some of the terms used by architects and builders today.

Pot and pit bunkers are small, rather round, deep bunkers with grass on the banks and either sand or grass on the bottom. It is difficult to advance a shot from these types of bunkers and they should only be placed adjacent or close to the greens. From this distance, the golfer can use a lofted iron to escape the hazard.

When using grass bunkers, thought should be given to where the golf shot is intended to land. A deep grass bunker adjacent to a narrow green with water on the far side will practically force the golfer to play laterally; whereas sand in this same bunker would allow most golfers to control the golf shot and give the the opportunity to aim for the pin. Size of the green, topography and adjacent hazards must be considered when deciding upon the use of either sand or grass.

Cross bunkers are slender, long bunkers placed across the line of play either in a fairway or in front of a green. These bunkers demand a heroic type of golf shot to obtain the preferred position either in the fairway or on the putting surface. At the same time, a safe and longer route is available for the conservative golfer.

The grass-faced bunkers that are common on the older courses have steep grass slopes with sand placed at the base. The steep slopes present on these bunkers were the result of minimal grading operations and inefficient equipment available at the time of their construction.

Today, we find that some golf courses are modifying these type of bunkers for easier maintenance, and then again, some new golf courses are incorporating them into their design for character. The maintenance concept and the budget will usually determine the type of bunker that is present on the golf course. Today, one change in the location of these bunkers over earlier models is that they are being strategically placed and are somewhat visible as the golfer approaches them.

A commonly used sand bunker is the cape and bay bunker, where sand is placed on constructed mounds and grass is placed on capes between and below the mounds. By varying the outline of the sand and modifying the heights and widths of both the sand and grass capes, the overall bunker becomes attractive. Some courses have expanded their bunkers and made the curving outlines less pronounced to allow for machine maintenance. As long as the sand is inexpensive, these bunkers are economical to maintain and still are attractive if the other features of the golf

course are designed and built in the same size relationship. These bunkers are built slightly into the ground with the adjacent mounds blending into the existing topography. The fairway bunker is built to allow the golfer to exit using a mid or long iron while the bunkers on the green approach area are somewhat deeper, demanding the use of a more lofted iron. In all cases, the bunker should always be constructed so that it can be properly drained.

Other ideas in bunker construction are used mainly to eliminate the maintenance of the grass or sand face and to add variety to the golf course. Some of the materials used are railroad ties, telephone poles, stones, and layers of sod. Even though these materials were used in the old courses, they add variety and character to the courses of today. Whichever bunker design or type of materials is used, it should be consistent with the design of the entire golf course.

There is no set number of bunkers that should be used on a golf course. Depending on the number of natural hazards, sand and grass bunkers may number from 20 to more than 100. The size of the bunkers will range from 150 square feet for pot bunkers to over 5,000 square feet for fairway bunkers. The overall conceptual design of the bunkers should be determined in the initial planning stages and should be followed throughout the design of the golf course.

When remodeling a golf course, bunker modifications should be made to improve the present conditions in location, drainage, and ease of maintenance.

Many of the older golf courses have some bunkers that are obsolete by today's standards but still possess character and distinction. Generally, many of the bunkers penalize the shorter hitter while not affecting the big hitter. The land area for the tee shot of the average golfer is between 175 and 225 yards. When renovating a golf course, the bunkers short of this area should be removed and replaced with bunkers in the area just beyond a good drive of the short hitter.

The relocation of the fairway bunkers provides an interesting, challenging test for the better golfers and a fairer test for the average players. The location of the bunkers should test the ability of all golfers, the use of the draw and fade, the chance to carry a bunker for better position, or playing short to avoid a hazard and still have an open shot to the green.

The design and construction of any new bunkers on an existing course should resemble the character, if any, of the present bunkers. Character can be developed through unique bunker design and construction. Proper bunker design will meet criteria of playability, fairness, flexibility, aesthetics, and practicality.

A concern of many people is the distance between a sand bunker and the putting surface. When riding mowers are used for maintenance, the bunker needs to be 6 to 10 feet from the putting surface to allow for machine operation. Placement of a bunker closer than this will require use of walking greens mowers or special care to avoid a wear area adjacent to the edge of the putting surface.

Bunkers placed over 20 feet away from the putting surface, as was the case in the 1950's and 60's made it easy to mow the turf, but the area became worn due to cart traffic compaction.

Also, bunkers placed this far away from the putting surface are out-of-play for most golfers as they approach the green. A better golfer can be 15 feet short of the putting surface with his approach shot and have his ball roll up to the pin. A bunker placed tightly against the putting surface demands an accurate approach shot, which is the true test of golf and would be fair for all types of golfers.

The problem with sand particles being sprayed on the turf by an explosion shot from the bunker can be solved by using the proper sand specifications, which coincidentally conform to specifications for topdressing sand.

When modernizing the bunker locations on an existing golf course, each golf hole needs to be studied and compared. Similar to new course construction, each hole is designed with variety, but has some unique features that unify the total golf course.

Meadowland, mountaintips, links, oceanside, whatever its type, a fine golf course will obey certain elementary rules best stated over 40 years ago by Bobby Jones: "The first purpose of any golf course should be to give pleasure, and that to the greatest number of players . . . because it will offer problems a man may attempt according to his ability. It will never become hopeless for the duffer nor fail to concern and interest the expert; and it will be found, like Old St. Andrews, to become more delightful the more it is studied and played."

In any and all bunker designs and construction, whether it is new or remodeling work, the ideal solution is taking natural design concepts that were suggested over 200 years ago and recreating them today for everyone's enjoyment.

RESPONDING TO PESTICIDE ISSUES

Sherry Blass, Len Conley, and John Crossmock

BACKGROUND INFORMATION

The lawn care industry has been faced with a growing controversy regarding the safety of the pesticides used in maintaining quality home lawns. As a result, lawn care companies have been put into the unfamiliar position of responding to a wide variety of local pesticide issues. Five major events have led to the present controvery:

Effect of DDT on Wildlife

The Rachel Carson Council, an outgrowth of the environmental movement, was formed during the 1960s. During this period, studies were being conducted on the detrimental effects of DDT on wildlife. Fueled by Carson's book, *Silent Spring*, the Council is one of the most active anti-pesticide groups today.

Agent Orange Controversy

A combination of the herbicides, 2,4-D and 2,4,5-T, "Agent Orange" was a defoliant used extensively in Vietnam. Many health-related problems among servicemen and their families were loosely linked to exposure to agent orange. Manufacturers of agent orange reached an out-of-court settlement with Vietnam veterans, further clouding the issue. A later government study concluded that there is not a higher incidence of these health problems in veterans' families when compared with non-veterans.

Environmental Protection Agency

Ann Gorsuch Burford made a serious miscalculation of public attitudes when she attempted to dismantle the Environmental Protection Agency (EPA). This gave unquestioned credibility and widespread public support to environmental and anti-pesticide groups, while casting doubt on the credibility of the EPA.

Clinical Ecologist Movement

Founded by Dr. Theron Randolph of Chicago, clinical ecology is a theory about the response of the body to a poison. Clinical ecologists believe that common symptoms such as headaches, nausea, dizziness, fatigue, and depression are due to environmental illness. Chemicals (or "poisons") used in our everyday life are seen as the cause, and treatment involves the elimination of these chemicals from the environment.

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Groundwater Contamination

Fifty percent of the total U.S. population relies on groundwater as a source of drinking water. According to a 1984 EPA list, twelve of the more than 1,000 registered pesticides used in agriculture have been detected in groundwater in certain situations. To date, no verified adverse health effects appear to be on record as a result of pesticide residues in groundwater used for drinking.

These and other events led to the formation and growth of a number of politically active anti-pesticide groups. Examples of these groups include: the National Coalition Against the Misuse of Pesticides (NCAMP), the Rachel Carson Council (mentioned earlier), and the Human Ecology Action League (HEAL).

These groups are made up of individuals who may:

1. Believe themselves to be hypersensitive.

2. Oppose any synthetic chemicals.

3. Oppose non-organic methods of growing crops for turf.

4. Believe that safety studies are not adequate.

5. Believe that "green grass" is not a societal benefit.

Lawn care is an easy target because our industry does business in highly populated areas, making us very visible. The odor that may remain after a lawn application, along with the perception among some individuals that beautiful lawns offer no benefit, compound the problem.

Pressure for further regulation of pesticides is a product of the increasing concern over the safety of pesticides and the growth of the highly visible lawn care industry. The manner in which we respond to these pesticide issues may ultimately determine the future growth potential of the lawn care industry.

COALITION

The effects of pesticides on the environment have been highly publicized since the end of the Vietnam War. Why? The industry, as a whole, is being judged on such publicized events as the spraying of agent orange in Vietnam. Why is this happening? This is the nightly news! Is this our industry? NO!

These national publicized stories are affecting the ability of the lawn care industry to deliver a quality service to our customers. How? These stories are setting a tone with local, state, and federal legislative bodies: legislative bodies that tie the applicator's hands and laws that require pre- and post-notification to our customers and their neighbors. Why is this happening?

Anti-pesticide groups such as HEAL and NCAMP are working together to publicize these so-called events. These organizations feed into the emotional issues that surround our industry. These organizations have become merchants of fear: merchants who have effectively sold their side of the story to the news media and the legislators who write the laws. These groups have effectively organized into coalitions across the country: coalitions whose members work to promote the negative effects of pesticides. Have they been effective?

In August 1983, Wauconda, a Chicago suburb, enacted a very restrictive pesticide ordinance that required posting of signs and pre-notification. Two years and $35,000 later, a federal judge found in favor of the industry, but what were the costs? Financially, the cost was near astronomical. The industry cannot continue to grow if these "Wauconda-like" ordinances go unchecked.

As an industry, we need to be active in the legislative process. As individuals, each of us needs to take an active role in our future. We must work together to promote our industry. An industry that is enhancing the beauty of lawns and landscape across the country. As an industry, we must tell our story--a story of safety.

As professionals, we must ban together in coalitions: coalitions that can tell our story at the local, state, and federal levels, a story that:

1. tells of an already highly-regulated industry.

2. tells of the university and in-house training programs for our applicators.

3. tells of the licensing requirements for these applicators.

As an industry, we have a strong story to tell. This story is best told through local coalitions: coalitions that, as businessmen, we must form and support; coalitions who must also work together nationwide and support national and state groups that support our industry; groups like the National Agricultural Chemical Association (NACA) and PLCAA on a national level, and the Illinois Fertilizer and Chemical Association on a state level; groups that can impact the legislators who regulate our industry. It's time we work together!

PROCEDURES FOR ADDRESSING COMMUNITIES REGARDING LOCAL PESTICIDE REGULATION

Establish Contact

The first step in the process is actually learning that either a concern exists over pesticide usage in a given community or that the community is considering pesticide regulation. You may hear of such a community through a newspaper article, from field personnel, a local Department of Agriculture official, a customer, a neighbor of a customer, or from another lawn care service.

Immediately, contact must be made with the community that is involved. The *Illinois Municipal Directory* has been an excellent source of names of city officials to contact. Occasionally, a city official will contact you to voice the concern of the community.

Determine Concerns

Once contact is made, you need to use good questioning and listening skills to determine the exact concerns of the community. This is a difficult process, because you are usually talking to an individual who does not share these concerns. This individual may tend to downplay the intensity of the concerns.

During this process, you can also start to learn who the key players are in city government. While you may be talking to an assistant city manager to determine concerns, you will want to get to the city manager (or above) when it comes time to address those concerns.

Schedule Meeting

Discuss with your contact which committee within the city government will consider local pesticide regulations. It may be an environmental committee, health department, legislative committee, or some other group. Set up a meeting with the particular committee to address the concerns of the community. Try to establish some ground rules that will be favorable to your presentation. For example, the less publicity that takes place about your presentation means a decreased likelihood of attendance by anti-pesticide activists.

Also, determine what type of presentation is to be made. Does the committee want specific answers to their concerns or a general presentation about the lawn care industry, followed by an opportunity to ask questions.

Design Presentation

Plan your presentation based on the concerns of the community. If the committee has requested general information about the lawn care industry, it may be helpful to utilize slides.

It is beneficial to consult with some of the other lawn care services in the area and solicit their involvement. However, one potential problem with joint presentations with other lawn care services is that each company has different strengths and weaknesses. Your presentation needs to accent these strengths. Be prepared to compromise when working in a group situation.

It is also very helpful to involve the operations side of the business. Without violating anti-trust legislation or giving away a competitive advantage, some operational information may be useful. The number of applications, service calls, actual pesticide complaints, and the tenure of field personnel in a given community are all good pieces of information. You can tie these numbers together to show the relatively small number of concerned citizens that are involved when compared with the high number of customers and neighbors the lawn service industry comes in contact with on a daily basis. You will probably find that the number of pesticide-related complaints is very small compared with the number of applications that are made.

Once you have outlined your presentation, make sure that you practice it thoroughly so that you are familiar with it. You must be ready to confidently tell the lawn care story so that you can sell it to the committee members.

Attend Meeting/Make Presentation

Show up at the meeting location early, dressed somewhat conservatively and ready to project a professional image. Be alert and act interested in the proceedings until it is time for your presentation.

While giving your presentation, try to remain confident and relaxed. Expect numerous questions from committee members and possibly from citizens in the audience. Direct your comments to the committee rather than the audience. It may take several public meetings for you to polish your presentation style to the level you would like.

It is most beneficial for someone to attend the meeting with you, preferably someone familiar with the lawn care industry. One of your goals during the meeting is to determine the vocal committee members who will shape the opinions of others. The observer will be able to do this while you are busy both making your presentation and thinking on your feet to answer questions.

The observer may be able to help present some of the information or answer questions that help your cause. Afterwards, this person can critique your presentation to point out your strengths and weaknesses.

Follow Up

It is important to follow up with your contact to determine the success of your presentation. Structure your conversation to indicate concern for the community while at the same time learning if your presentation was successful. You will also want to discuss the results of your presentation with any other lawn care services that were involved.

Above all, leave open the lines of communication with the community. Make sure that individuals feel comfortable contacting you regarding any concerns that arise in the future. Make sure they are left with a very good impression of the lawn care industry.

MEDIA COORDINATION

As controversial, broad-based, and human interest topics, pesticide concerns receive their share of media coverage. Expect press, radio, and TV attention as specific events/incidents arise, whether you really want it or not. For continuity, it is highly advisable that one individual be identified as media spokesperson. Thus, information is focused, consistent, and predictable.

Keep it simple. Choose the main points of your message and repeat them. Know them by heart. Know them under pressure. Say them in different ways, but repeat them! Use key words. "Safe" and "necessary" are appropriate for pesticide use, "vague" and "unreasonable" for pesticide regulation. Remember to use words that are clear and understood. Try simple analogues with which your audience can relate, such as "pesticide allergies may occur just as allergies to food, pollen, or wool."

Don't avoid questions. Answer difficult or unfavorable questions briefly and return to your main points. Become a reliable source. If you don't know an answer, or feel very uncomfortable, don't be afraid to say so. *However*, be prepared to find out or know cooperative contacts and referrals. Individuals in related fields such as golf course maintenance and structural pest control, political contacts, directors of industry organizations such as the Pesticide

Public Policy Foundation, and the Illinois Fertilizer and Chemical Association, Cooperative Extension Service staff, editors of trade publications, and "expert referrals" such as toxicologists, allergists, and veterinarians are all people for which you should keep a ready list.

Be wary of becoming "too comfortable" with media spokespersons. Do not say something you wouldn't want reported. Avoid all "off the record" comments. Never be flippant, cute, or sarcastic when answering questions. Remarks are easily misinterpreted. At best, you appear thoughtless: at worst, a vicious purveyor of chemicals with "nary a care" for public safety or environmental preservation.

Likewise, avoid presenting "financial considerations" as a basis for your decisions and actions. However, you can explain opposition to local pesticide regulation based on the "tremendous and unnecessary consumer costs." Your role must be one of protecting the public rather than profiteering businessperson.

In deciding whether to participate in a specific interview, get to know your local media contacts. Understand whether the interviewer/reporter will be sympathetic or adversarial. Try to obtain questions and a list of other participants ahead of time so you can be most accurate and helpful. If they are unavailable, be familiar with your opponents' main arguments, at the very least. It is acceptable to not accept an especially hostile or volatile interview. The worst that can be said is that you were unavailable for comment or had no comment. It is better to say nothing at all than to lose ground because you are unprepared, overly emotional, or fielding rapid-fire questions from a battery of opponents. However, it is quite unacceptable to repeatedly and deliberately avoid interviews. Reporters are human and generally have the upper hand due to their position. It is not to your advantage to alienate them. If you have done your homework, interviews requested on short notice may be accepted with minimal apprehension. Remember, if prepared, you are more knowledgeable than the reporter, or moderator, or host whom you will be educating. It is not uncommon for the interviewer to mispronounce technical words or confuse legal intricacies. Don't take undue advantage here, but *do* correct these misnomers in a professional manner.

You will find that interviews with the written press are requested more often. Because of this on-going relationship, "off the record" remarks are most tempting. Maintain a professional distance. Be wary of on-the-spot interviews after emotional or unexpected events. Ask the reporter to contact you the following day after you have had time to regain your perspective.

When interviewing via phone, don't hesitate to tape record the conversation (after informing the other party, of course). This helps to avoid out-of-context and misrepresented remarks making it into print.

Television and radio interviews present a different set of challenges. Due to air time constraints, your careful, lengthy explanations are usually edited to mere seconds. Because you have no control over the editing process, it is even more important to stick to your main points and repeat, repeat, repeat! Unfortunately, one misspoken phrase may be all that airs. For this reason, live interviews are more controlled and, though somewhat unnerving, are to your advantage. In either case, find out how long the interview will be, both actual discussion and edited "air" presentation.

Maintain your composure no matter what. The five main rules follow:

1. Smile! It will help you relax, besides enhancing your general image and credibility.

2. Talk slowly. It is better to appear thoughtful than impertinent and harried. Fast-spoken interviews often appear as if the interviewees are rushing to hide something. During a live discussion, pauses are most appropriate for collecting your thoughts. What seems like dumbfounded silence or agonizing stammering to you sounds surprisingly (thankfully!) deliberate.

3. Be aware of body language. Stand straight or sit on the edge of your chair, but don't slump or slouch. If your eyes wander from a straight-ahead, forthright gaze at the interviewer, make sure they go down. Down is thoughtful, but up is emptyheaded or sarcastic, and sideways is conspiratorial and distrustful.

4. Use props to lend credibility. Professional garb and a notebook with a library at your back often do more for your message than your actual words.

5. And remember--you know (or should know!) far more about the subject than the interviewer. Use your knowledge like a healing balm for your jangled nerves.

Finally, your message is an advertisement for the entire pesticide industry. Recognise it as an opportunity. And although many have said that the best media we can expect to receive is neutral, a neutral image is far better than the more familiar options.

LAWN CARE: THE GREEN INDUSTRY

Have you ever stopped to consider the benefits of a nice lawn or landscape? Given the fast pace of today's society, these benefits can be easily overlooked.

Today, more and more homeowners, landlords, businesses, and communities are realizing that the quality of your surroundings can have a direct impact on the quality of your life. The lawn care industry takes pride in providing professional services that enhance that quality of life.

Value of Your Lawn

Turfgrass is important in human activities, providing functional, recreational, and ornamental benefits. Some of the benefits follow:

- soil erosion control
- visually enhanced landscape areas
- reduced glare, noise, and air pollution
- habitat reduction for disease carrying rodents

- increased cushioning for effectively reducing outdoor sports injuries
- an aesthetic environment in which to live, work, and play

Home lawn and other turfgrass areas have significant, direct economic value. A typical 5,000 square foot home has an approximate value of $2,500, a substantial investment. The desirability and value of your neighborhood and your home is substantially improved through attractive landscaping.

Care of Your Lawn

It is impossible for a high-quality lawn to flourish from year to year without damage from weed, insect, and disease pests. The weed and insect control products available today are effective, safe, and in many cases, the only means available for controlling pests in the home lawn. The absence of these products would result in economic loss to the individual and community. Lawn care companies make these services available for individuals who lack the time, expertise, physical capability, or desire to personnally manage and maintain their lawns.

A highly competitive marketplace and increasingly educated consumer, along with federal and state regulation, help shape the lawn care professional. High quality standards are professionally maintained through:

- training programs
- safety procedures
- record keeping systems

Training

The lawn care professional frequently comes to the industry from the university community with training in an agricultural curriculum. These academic backgrounds are expanded by comprehensive, on-the-job training. Instruction includes:

- safe handling, storage, and use of pest control products
- diagnosis of pest problems and recommended treatments
- lawn watering, mowing, and other cultural practices

Additional support is provided to the lawn care professional through university and trade association programs. The Professional Lawn Care Association of America (PLCAA) is a direct result of the high standards maintained by the lawn care industry.

Safety Procedures

To the lawn care professional, safety is the benchmark of the work environment. Safety encompasses handling pest control products, along with personal health and hygiene. Strict quality control measures insure the safe handling of pest control products. These measures include product storage, mixing and filling of tankers, and proper spraying techniques. Personal health and hygiene, including proper attire, round out these quality control measures.

Record Keeping Systems

State pesticide regulations provide for a uniform record keeping and auditing system. These records are essential for determining the effectiveness of control programs. The professional can use these records to make selective applications for pest outbreaks.

Record keeping systems are vital to maintaining quality customer service. These customer records enable the professional to meet personalized customer requests.

To better understand pesticide regulations, one should examine:

- federal and state laws
- enforcement
- system safeguards
- pesticide labeling

By examining these four areas, one can better understand the complexity of pesticide regulation and the built-in safeguards that protect man and the environment.

Federal and State Laws

All products used by the lawn care industry are controlled through stringent laws at both the federal and state levels.

At the federal level, the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) insures that pesticides that are registered for use present no unreasonable, adverse effect to man and his environment. FIFRA controls the labeling, use, enforcement, handling, and licensing for all pesticides. FIFRA provides the framework for state pesticide laws. This continuity between federal and state regulation insures consistent implementation and enforcement by all fifty state laws. Provisions within FIFRA preempt regulation below the state level.

At the state level, the provisions of FIFRA have been made into an operationally enforceable law. Authority for registration, licensing, and enforcement clearly ends with state laws.

Enforcement

At both the federal and state levels, provisions for enforcement have been established. The provisions include:

- authorization to stop the sale and use of any pesticide
- investigation of complaints concerning pesticide injury, misuse, mishandling, or reported excessive pesticide exposure
- initiation of civil or criminal charges
- leveling of fines

Enforcement rests with the Department of Agriculture, the EPA, or the Attorney General's Office.

System Safeguards

Due to the dynamic nature of pesticide registrations and labeling, review committees have been established at both federal and state levels. Their main purpose is to review and recommend changes relating to the storage, handling, sale, and use of pesticides. The committee meets quarterly to review such topics as:

- pesticide packaging standards
- disposal of pesticide containers
- issuance of experimental use permits
- pesticide research and pesticide alternatives
- pesticide usage and impact to the environment

These on-going committee reviews provide up-to-date recommendations needed to insure safe use of these products.

Pesticide Labeling

Labeling of pesticides is a process based on stringent guidelines clearly defined by the Federal EPA. Prior to issuance of a produce label, the following analysis is completed by the EPA.

- field effectiveness in controlling the target pest
- residue on the target crop
- safe handling and use of various product formulations
- environmental effect on soil, water, and air
- short/long term toxicological studies on animals, fish, and plants

These tests were established to assure that the product can be used effectively, according to label directions, and without causing unreasonable adverse effects to man or the environment.

The labeling of a pesticide by the EPA is one assurance that the product meets all requirements, that supporting data have been reviewed, and that the resulting conclusions have been accepted by qualified government scientists. Product use contrary to label directions is illegal and punishable according to federal law.

Lawn Care Products

Lawn care companies use products that can be purchased over-the-counter by anyone at garden centers, hardware stores, grocery stores, and other retail outlets. As service companies, lawn care products are chosen that meet consumer standards for safety, effectiveness, and cost. These products selectively control weed and insect pests in lawns but present an insignificant health risk to humans, pets, and the environment.

This safety is illustrated by these common household comparisons:

- A person would have to ingest over 40 cupfuls of lawn clippings treated by ChemLawn to equal the toxicity of a single cup of coffee (residue calculated on a wet-weight basis).

- Many common household products are rated at a higher level of toxicity than a typical ChemLawn application, including aspirin, library paste and glue, Easter egg dye, detergents, ink, shaving cream, denture cleaners, deodorants, suntan lotion, modeling clay, cooking oil, and many more.

- One hundred cupfuls of freshly treated grass clippings have the equivalent toxicity of a 0.7 teaspoonful of table salt, 6 teaspoonfuls of sugar, 15 ounces of milk chocolate, or a 2-ounce martini.

TELEMARKETING

Barry Matthews

Before I get into my thoughts on telemarketing, I'd like to get an indication of what you feel about telemarketing in general. I'd like to know how many of you think telemarketing is the best thing that ever happened to the lawn care industry. Next, I'd like to know how many of you think it's one of the least desirable advertising choices available.

The typical response to this poll finds the majority in the opinion that telemarketing is not among their favorite advertising choices. What is the reason for this? Actually, some people feel it's immoral to call someone at their home in the evening to promote a product or service...and in some cases it is!

Have you ever gotten this type of call before?

"Hello?"

"Hello, Mr. Johnson, this is Dave from No Name Lawn Care, and I want to offer you the opportunity for a free, no charge or obligation, one-of-a-kind lawn survey. We'll have one of our famous experts in your area sometime this spring, and we'd like to stop in to show you how our unique program will work miracles for you. We'll control the weeds, make the lawn green, treat disease and insects, offer you discounts, give you gifts, and do whatever else it will take to satisfy you, your wife, and your kids. What do you think, Mr. Johnson, are you prepared to..."

Well, you get the idea: this is one of those pushy calls that doesn't allow you to get a word in. This type of approach is what most people perceive as the standard telemarketing call. This type of call leaves a bad impression with the consumer. It's the call made by the pioneers of telemarketing. You know who they are. They've probably called you. There's Al's Aluminum Siding, Wally's Thermal Windows, Ralph's Roofing, and often times the local newspaper.

Today, telemarketing has changed. It's become more sophisticated in its operation and quality and has thereby gained some consumer acceptance. As costs of other direct marketing media rose, many companies turned to telemarketing to reach prospective buyers of their products and services. The lawn care industry has been no exception. As reported in the March, 1985 issue of *Lawn Care Industry* magazine, a state of the industry report concluded that 21.1 percent of all lawn care operators are now using telemarketing to promote their businesses.

By the mere fact that telemarketing is on the rise in the lawn care industry, one might assume it's the thing to do. On the surface, the concept seems simple. After all, what does it take to start a telemarketing program? Sit down at

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Barry Matthews is Regional Representative, Spring-Green Lawn Care Corporation, Plainfield, Illinois.

a phone, open a directory, and you're in business, right? Well, look beyond the surface and you'll find it's not that simple. I'd like to share with you what I've learned lies beneath the surface of a telemarketing campaign. At Spring-Green, we first began to look at telemarketing several years ago. At that time, we had questions and concerns that needed answers. As with all media selections, we needed to identify the advantages and disadvantages of the program.

In comparing telemarketing to other media choices we first asked if telemarketing could offer a consumer reach advantage. In other words, would we be able to contact more prospects? The lawn care industry has always attempted to reach prospects by means of direct mail, newspapers, Yellow Pages, radio, and more recently, some of the major companies have plowed advertising dollars into television. Each of these media has a far more limited audience than the telephone. The potential buyers one can contact with a telemarketing program are only limited by the number of homes in a market and the percent of those having unpublished phone numbers. Consumer reach, then, is clearly one of telemarketing's advantages.

We then asked, "How would a telemarketing program impact our company's image?" This was a big concern of ours, and I'm sure of most companies. After all, we did not want to associate our name with a program the consumer thinks of negatively. What we learned was a poorly scripted telemarketing call, made at the wrong time, and by the wrong type of caller, does in fact negatively affect a company's image. The impression left by a poor telemarketing call stays with the prospect much longer than does any impression from a direct mail brochure. However, a well thought out and prepared program can overcome some of the negative image consequences.

Another aspect of telemarketing that can negatively impact a company's image is how many times a prospect is called. I am aware of many telemarketing programs that have been designed to beat on the prospect to the point that he either submits to the caller's request, in an effort to keep the phone from ringing again, or he threatens to call the Better Business Bureau if the harrassment continues. Believe me, this happens. A telemarketing program that lacks quality is a real threat to your company's image. Therefore, we identified this potential impact on image as a definite disadvantage to a telemarketing program.

Also of concern to us was how flexible the operation of a telemarketing program could be. We needed to know if the small lawn care business could set up a telemarketing campaign as effectively as the large lawn care business. This was a concern because our initial exposure to telemarketing was a large boiler room type operation. The program was run by an independent firm. In a big room, this firm employed twenty to thirty callers supervised by two or three management people. The telephone systems, work areas, and procedures were all first class and so was the cost. It quickly became apparent that, not only was the cost a disadvantage to the small lawn care operator, but also the location of these services, being only in major metropolitan areas, was a disadvantage as well.

What we then did was take what we learned from this boiler room operation and scale things down to fit operations ranging in size from the new entry to lawn care to the well-established business exceeding one million dollars in gross annual sales. Each size of operation required its own set of operating procedures, but telemarketing has worked to the advantage of both large and small businesses.

In the Spring-Green Franchise System, there are not only large differences in size, but also differences in market types. Our market types vary from those having little exposure to lawn care, which we call a Market Type One, to those markets which are painfully aware of lawn care, which we call a Market Type Five. This brought up the question: "Does market type influence the success of a telemarketing campaign?"

What we found was a real mixed bag of tricks. Generally those markets that are painfully aware of lawn care got that way through telemarketing. A couple of examples from the list are Milwaukee, Wisconsin, and Fort Wayne, Indiana. In these markets, everybody and their brother has at one time or another used telemarketing not only to promote lawn care, but also every other product and service imaginable. Between the hours of six and ten each evening, these telephone systems are among the busiest in the country. In markets as mature as this, telemarketing is still producing results but getting the results takes a lot more work. First, it takes more calls to reach the individual who will allow you to do an estimate and second, because of the number of competitors, the selling process is more intense.

At the opposite end of the spectrum is Market Type One. This is a market having very little exposure to lawn care. There may be one or two small, independent LCOs in this market type which have built their business through word of mouth and newspaper advertising but not telemarketing. In this market type we found telemarketing to be an acceptable alternative to expensive direct mail advertising, but because lawn care awareness was low, results were not as high as expected. When making these telemarketing calls, there was more time spent explaining the service, which then reduced the caller's efficiency.

The best markets for telemarketing were determined to be Market Types Two through Four. In these markets you find at least a general awareness of lawn care and some exposure to telemarketing but neither to the extreme of a Market Type Five. The answer to our question was: "Yes, market type has a big influence on telemarketing success." Depending on your market type, you can designate this an advantage or disadvantage.

When investigating telemarketing, we, of course, were not just interested in generating leads; we wanted to sell those leads. The natural question was "How well could we expect telemarketing leads to convert to sales?" The important difference between telemarketing and other direct advertising media is sales conversion as a percent of leads generated. Keep in mind that a lead from a direct mail brochure or a newspaper ad places the burden of response on the prospect. This means the prospect has to either call your office or mail back a brochure card in order to request an estimate. Because the prospect had to make this effort, you can be sure he or she has a genuine interest. On the other hand, telemarketing requires no effort from the prospect. You initiate the action by calling the prospect directly. You have no idea if the prospect has any interest at all in lawn care before you call and, as you quickly learn, you don't know their level of interest after you call unless the prospect gives you a definite "no." Too many times prospects say "yes" when you ask permission to do a free estimate just to get you off the phone. It's no skin off their back to say "yes"; after all, you tell him there's no obligation. Also, many telemarketing prospects have just a passing interest or say "yes" because they are casually interested in comparing the price with their current service.

What you can expect in sales conversion of telemarketing leads is far less than what you've experienced from other direct advertising media. How much less? Well, half as much would be outstanding, but a conversion of 1/3 of the results achieved through other media is more likely. Since conversion is so much less, it takes considerably more effort on your part to meet a sales goal. Sales conversion should, therefore, be identified as a disadvantage.

Other areas in question on our original list included labor costs, quality of customer, and total cost of sale. We knew from the outset that our labor cost would be higher due to the number of callers to be hired and the greatly increased number of estimates to be performed. What we did not anticipate was high turnover and its associated costs. One thing you can count on when telemarketing in turnover is that it's sort of like a revolving door: as soon as you have filled one caller's seat, the next seat is empty and the process goes on and on. This is one of the biggest disadvantages to telemarketing.

The question pertaining to the quality of customer that telemarketing produces was somewhat of an afterthought. What we learned is that a telemarketing customer is not as committed to or as loyal to your company as customers developed through other sources. The telemarketing customer is more likely to cancel service during the season. Remember these customers often are not as interested, so many times they tend to take one application just to try it. The resulting quality of customer obtained through telemarketing is, in my mind, a disadvantage to the program.

From the information I've provided so far, you may get the impression that total cost of sale would also be a disadvantage, but first you need to ask, "compared to what?" Total cost of sale can be calculated in as many ways as the number of individuals formulating the calculation. One person may include costs that another person feels should be analyzed differently. In general terms, you should find the telemarketing cost of sale to be less, to some degree, than other direct advertising media. This should, therefore, be identified as an advantage to telemarketing.

The questions and concerns I've discussed so far have focused more on the immediate consequences of a telemarketing program. A big question remaining is "What does the future holds for telemarketing?" How long will telemarketing be a reasonable approach to direct marketing. The lawn care industry, for a long time, depended on direct mail. Over the past several years direct mail costs have gone up as results have dropped off. At some point, the same will happen with telemarketing. As a matter of fact, telemarketing has already run its cycle in some markets. How long it will be viable in most markets is a question I don't have a definite answer for. What I can tell you is I suspect telemarketing effectiveness to be short-lived. At Spring-Green, we recognize the need for new, innovative marketing ideas if we are to continue to prosper in the lawn care industry.

BUNKERS FOR GOLF III: MAINTENANCE STYLES

Jerry L. Faubel

Every aspect of golf course maintenance has become more intensive. Faster greens, closely cut fairways, better sand bunker maintenance, and the like.

Construction of the bunker is important, while the proper sand is very critical to successful maintenance and its acceptance by the golfer. Consistency from bunker to bunker throughout the entire golf course is of great benefit to the golfer; once he has experienced the condition of one bunker, he then knows what to expect and can play the shot with confidence. On some golf courses, golfers are carrying two sand wedges to use under varying sand conditions. Hopefully, this situation can be rectified.

Sand for bunkers should have a fairly narrow size range (0.75 to 1.0 mm, but perferably more toward 1.0 mm). Bunker sand should be free of clay, silt, or small gravel. Clay and silt cause the sand particles to fluctuate and form a crust on the surface. This also delays the drying of the sand and makes it harder to maintain. Clay and silt are the major factors in reducing the quality of the playing surface in a bunker. To increase the useful life of sand, proper bunker construction is essential. Surface water from the surrounding area should be diverted away from the bunker. Only water falling directly onto the bunker surface should enter the bunker. Drainage tile should be installed in every bunker and connected to a proper outlet.

Sand does not wear out. It loses its favorable characteristic because it is contaminated with silt and clay. White silica sand is probably the most preferred type of bunker sand. The white color is probably the reason for its appeal. Unfortunately, throughout most of the United States, it is unavailable at economical rates for bunker use. The white calcareous sand found in the gulf and coastal regions is economical for the area and is highly desirable for bunkers.

Before the advent of the powered sand rake, maintenance of sand bunkers was done by hand raking. Cultivation of the sand was an arduous task requiring many hours of labor. The mechanical sand rake reduced costs of bunker maintenance drastically. Sand was cultivated every day at less than one-fourth the labor cost. Golfers had to learn how to hit a shot from fluffy sand. Buried lies are frequently found when sand has been cultivated. Ridges and tire marks caused by the powered sand rake have required a higher skill level on the part of the operators. Powered sand rakes have a tendency to level all areas in which they are used. Hand raking is still required for edges and contoured areas of the bunker.

The leading or front edge of the bunker should have a lip of 1 to 2 inches to maintain the integrity of the hazard. The back edge of the bunker should not have a lip. Sand should be even with the back turf area to enable the club head to make contact with the ball before it strikes the sand.

Jerry L. Faubel is Golf Course Superintendent, Saginaw Country Club, Saginaw, Michigan.

Edges of all bunkers should be well-defined. The golfer must know if the ball is in or out of the hazard. Trimming or edging the turf on the perimeter of the hazard is easily accomplished with the small engine-powered edgers or trimmers that are available. If used frequently, handwork is held to a minimum. If widening or reshaping of the bunker is desired, then a mechanical sod cutter or square nosed spade with a sharp edge is useful.

Proper construction of bunkers can save a considerable amount of time in their care and maintenance. If the bunker face is cut deep and straight down, it helps prevent erosion of the sand.

Drain tile should be enclosed in a geotextile fabric. The fabric prevents the sand from entering the drainage system. If the new, highly porous materials are used, the pea stone is not needed around the tile line. Drainage should always be installed below the base of the bunker to avoid any contact with maintenance equipment.

Liners have been used before in bunkers; however, they were not as permeable as the new geotextile fabrics. If a liner is to be installed, it should be placed well below the reach of any mechanical sand rake. Once the material has been inadvertently lifted to the surface, it is very difficult to put back in place.

Sand depths should be checked frequently to insure an even depth. The power sand rake will move sand to certain areas of the bunker if the operator rakes the bunker the same way each time. To avoid distribution problems, the operator should vary the raking pattern along with the place the rake enters and exits the bunker. To move sand within the bunker, a front blade can be attached to the power rake. It is a most effective option and saves many man hours when used by a skilled operator.

Sand may be added to bunkers to maintain the 6- to 8-inch depth that is most desirable. Small lightweight vehicles can be used to carry the sand to the sight. Heavy pieces of plywood can be used next to the bunker to avoid tire marks. If a large quantity of sand is being added, then the superintendent may wish to add it during the winter when the ground is frozen to avoid damage to the area. Distributing large amounts of sand in large bunkers is most effectively carried out by using a Bobcat or similar type of vehicle.

Golfers prefer to play at well-maintained facilities. Most superintendents have the knowledge and skills to keep their facilities in the best condition. The popularity of golf is due largely to the ability of the superintendent to maintain superior playing conditions. Our industry is meeting the challenges of today through its aggressive, positive attitude and a willingness to get the job completed. Because of this attitude, our industry remains viable and maintains growth. Golf is popular and superintendents are part of the reason for this popularity.

BUNKERS FOR GOLF IV: COST ANALYSIS IN GOLF COURSE MANAGEMENT

Fred D. Opperman

Trying to tell you what it is going to cost to maintain your sand and grass bunkers is like trying to tell you what the weather will be like the next day, especially if you live in the Chicago area. I can't tell you exactly what the weather will be the next day, and I can't tell you the exact cost of maintaining your sand bunkers. What I *can do* is give you some average costs, some "ball park" figures, and some estimates of what I have found the cost may be. There are so many variables to contend with, such as the number of bunkers on the course, degree of maintenance required, age of bunkers, and steep slopes, as well as no slopes, capes or bays, equipment required, and man power. You also have to consider your budget, weather, sand type, where the course is located, the origin of sand, cost of trucking, time of year, and on and on and on. Unfortunately, I have left out as many variables as I have mentioned. I believe you may be getting the picture I am trying to paint: that what I have to say about the cost of maintaining sand and grass bunkers is not an absolute figure. However, I do believe that you may go away with a better understanding of what the costs might be after I have finished today.

I sent a survey to 16 private, 18-hole golf clubs. I picked private clubs and clubs with only 18 holes of golf for a comparison of sand bunker maintenance. The questions asked were: number of bunkers on course, how many hours required to rake bunkers per day, how many times per week they are raked during the golf season, how many men used, how many machines used, number of times the bunkers are edged, number of hours required to edge and trim, average rate per hour of manpower for bunker maintenance, if they knew the square footage of their bunkers, how often sand is added, and how is it added.

The results of this survey show that out of the 17 clubs (including my own club) the average was 66 bunkers per club, with the low being 37 bunkers and the high being 89. The average hourly rate for bunker maintenance was $4.50 per hour with the low rate being $3.50 and the high rate $5.25 per hour.

The clubs average 4.8 hours per day to rake their bunkers: not man-hours, but total hours to complete the job. The next question was, "How many men were needed to rake the bunkers?" The average came to 2 men. With this information, the average amounts to 9.6 man-hours per day and at the average rate of $4.50 per hour equaling $43.00 per time or day to rake sand bunkers.

Next question asked was, "How many times per week in season do you rake your sand bunkers?" The average is 5 1/2 times per week during the playing season. This cost per week would be $225 for bunker raking.

Fred D. Opperman is Golf Course Superintendent, Glen Oaks Country Club, Glen Ellyn, Illinois.

Another question asked was, "Do you have soft or hard sand?" This question led me to the podium, today. We have soft sand at my club, and the members were just about to get a rope to lynch me up due to the conditions of so many buried lies. This all took place during early June when we had no rain and we had a lot of play. The greens never needed to be watered, but the sand bunkers needed to be constantly raked due to the heavy play. Well, dry sand being raked constantly with a toro trap rake makes for soft sand. My green chairman happened to be playing Hilton Head this past spring and saw a trap rake that had regular leaf rakes replacing the usual rake. He took pictures of the rake, and we outfitted our rakes the same way. Of course, since we started using the leaf rakes on our machines, the traps became firm. At about the same time, we got some rains, and we started to water our greens; the membership believes it was the trap rake that made the difference. At any rate, it was through the soft sand and the "stink" that the membership was putting on about the traps that led to Jim Latham being called in. If Jim hadn't been called in, I may not be here, today. But getting back to the question of soft or hard sand, the results are 10 had soft sand and the others had hard sand.

The next cost item on sand bunker maintenance is the number of times the bunkers are edged and the manpower and hours used for this chore. The average number of times they are edged is 3 1/2 times per year. One club edges only once per year and another club stated that they did it 7 times. In the hours spent edging, there is a great difference from the low of 16 hours to the high of 320 hours, with the average being 90 hours to complete the job. At this point, I regret to add that I didn't ask the number of men needed to do this chore, so I do not have an average from the Group 1 surveyed. But from my own records it takes 20 to 25 hours with a crew of 4 to complete edging our 74 bunkers. If I use this figure, the cost using the 25 hours times 4 men used on the job would equal 100 man-hours. Multiplying 100 man-hours by the hourly rate of $4.50 equals $450 per time to edge the sand bunkers. Four hundred and fifty dollars times the average of 3 1/2 times per year (the number of times the sand bunkers are edged) gives us a cost of $1,500 per year.

Other added maintenance chores for sand bunkers include the shoveling up of sand that has been washed down after heavy rains and the raking out of debris and leaves in the bunkers. The weeding of traps, I felt, was done when the traps were edged. The question of shoveling up of sand was not asked in the survey, but through my own records over the past couple of years, we seem to do it on the average of 5 to 6 times per year: that is, outside of the times that the bunkers are edged. In my own case, we use a toro trap rake with a plow on the front to push the sand. We haven't had to use shovels for a few years. My man-hours for this chore average 12 hours, and the cost would be $54 per time or a yearly cost of about $325. Of course, there are those times when we all have done it 3 to 4 times in one week. I do not have the cost of debris removal from bunkers. I usually do this job in the spring along with the first edging, and this chore is tied to the edging.

To sum up the yearly costs of raking, edging, weeding, and pushing up sand back from the slopes, we have the following costs:

$225 per week for raking x 20 weeks	=	$4,500
$129 per week for raking x 6 weeks	=	774
$450 per time for edging x 3 1/2	=	1,575
$54 per time for pushing sand x 6	=	324
Total cost per year	=	$7,173

Included in the cost of sand bunkers is the equipment used for their maintenance. Mechanical power trap rakes will cost about $7,300 per machine, and the survey shows that most private clubs have two machines, for a total $14,600. Besides the power trap rakes, you must have hand rakes, both for the golfers and the crew. The cost of these rakes will run from $4.25 to $21.95, with the average rake costing $10.75. With an average of 66 bunkers per course, you have an investment of $4,257 in rakes for the bunkers, if you use an average of 6 rakes per bunker. Add to this cost the number of rakes you have in your maintenance building and the number of shovels, and you can add another $300 to the maintenance of sand bunkers.

You will also need the equipment for edging and weeding your bunkers. There are various tools for this job--anything from a sod knife, to a motorized trap edging machine, to string trimmers. At Glen Oaks County Club, we will use any or all of the aforementioned items, depending upon how much of an edge we will be removing. Most times we just use the string trimmer and do not remove any soil. I can recall seeing a slide that Ted Woehrle showed some years ago of the results of what happens when you constantly edge your traps and remove soil each time. The slides were basically a 10 years before and after slide presentation. The "10 years before" picture showed a sand bunker with a grass cape coming down into the bunker, and the present-day slide showed the same bunker, except that the cape had been totally edged away, and the edge of the bunker was now at the extreme top of the present-day bunker. Consequently, after seeing the dramatic results, I have since stopped using machines, on any regular basis, that remove any soil.

The cost of these tools will run from $35 for the sod knife/edger to $325 for a power sand edger or string trimmer.

Up to this point, I have been discussing sand bunkers. Now we need to consider grass bunkers. Unfortunately, most of the bunkers in the Chicago area are sand bunkers, but there is one club that stands alone in our area that you could say specializes in grass bunkers, the Chicago Golf Club in Wheaton, Illinois. Chicago Golf Club, being one of the oldest clubs in the country and maintaining itself in its original design, has some really great grass bunkers. All of its sand bunkers are flat, with no sand on any slopes. Think of that... never having any sand washing down after a rain storm. There are 106 grass bunkers and slopes throughout the fairways and greens. The grass bunkers are mowed about every 2 weeks during the season, with a total of 42 man-hours per time, at an hourly rate of $4.60 per hour. This costs about $193 per time, and they are mowed about 12

times per year for a total cost of $2,316 per year. The majority of the bunkers are mowed by hand using 2-cycle rotary mowers. Many times ropes must be tied to the machines, and they are lowered and pulled back up the extreme steep slopes. The sand bunkers are edged only once per year. There is seldom any time spent in shoveling sand, no blowing of the sand takes place due to the deep protected bunkers, and very little raking of the sand is done by the crew. The golfers do most of the raking, and they like their sand hard, which it is due to the little amount of mechanical raking by the crew throughout the year.

Now to get back to the survey of the clubs and the question, "Do you know the total area of sand in your bunkers?" Out of the all the clubs, only 6 knew the square footage of the bunkers. I didn't even know my own area of sand at the time I sent out the survey. Since then, I have taken inventory of our sand bunkers. It is surprising to see both the total area one has and the individual sizes of various traps. Out of the 6 clubs, the average square footage was 140,000. The low was 93,600, and the high was 300,000 square feet of sand. With the average of 66 sand bunkers per course and the average of 140,000 square feet per course, the average sand bunker in our survey is 2,120 square feet.

We asked when and how frequently sand was added and the results were 10 added sand as needed, 3 do it yearly, and the rest do it every 2 to 3 years. The average cost of sand replacement in the budgests was $3,000 per year, with the low budget being $500 and the high being $7,200 per year.

When asked if sand is just added to your bunkers, eleven responded "yes" and the others" no.

So far, all I have discussed is the daily and seasonal maintenance of our bunkers and their approximate related costs. Now I would like to talk about the areas of construction and the addition of sand to the bunkers.

One of the first items that might be to have sand samples that you are considering for analysis. The cost of sand analysis is rather inexpensive when you consider the overall cost of adding sand to your bunkers, and you certainly want to make sure that you will be adding the right sand. This past spring I had three samples analyzed at a cost of $150 ($50 per sample plus shipping). Shipping costs were $28 by UPS. If you are going to be spending thousands of dollars on sand, you do want to be sure it is the proper sand for your bunkers. This analysis will give you the sieve analysis and they will give you the mechanical analysis of your samples. One hint I have for you, if you have the time to send your samples in, try to dry the sand first to make it lighter for shipping. Most labs will ask for about a gallon sample, and this can get heavy if wet.

Now I want to speak about the cost of sand replacement. Again, all the variables come into play: how many bunkers, what size, how far from the source of your sand, type of sand, where you are located, and the like.

I found sand prices per ton to vary from $2.85 per ton to $9 per ton. This price does not include shipping. Shipping prices depend on the distance from the source of the sand, how much competition in trucking is in your area, if you are located in the inner city, suburbs, or "boonies," or if there is a return load the

trucker may pick up. Some trucking firms will charge a flat fee of, say, $1.75 per ton for the first couple of miles, then maybe $0.25 per ton after a certain number of miles. Again, it is difficult to say what the cost of sand will be until all the variables are checked.

To find out what the sand is going to cost, you must first know how much sand will be needed. You had better find out the square footage of the trap or traps that will be requiring sand. Then you can figure out the tons of sand required.

To figure out the quantity of sand, you should remember or jot down that:

1. Sand weighs about 96 pounds per cubic foot.

2. One ton of sand will cover 22 cubic feet.

3. This one ton of sand will cover 44 square feet at a depth of 6 inches or cover 66 square feet at a depth of 4 inches.

The formula for determining the amount of sand required in a sand bunker follows: length x width x depth needed (expressed in a decimal such as 0.5 = 6 inches, 0.33 = 4 inches, 0.25 = 3 inches) x 96 (which is the weight of a cubic foot of sand) divided by 2,000 (which is the number of pounds of sand in a ton) will give the total tons required.

With this formula, if we take our survey results that state the average trap to be 2,120 square feet, and if we have removed all of the old sand and need to replace it with clean sand to a depth of 6 inches, then we need to multiply the 2,120 square feet by the depth of 0.5 (which is 6 inches) and times that 96 pounds per cubic feet. That figure then needs to be divided by 2,000 pounds to give us the 51 tons of sand needed to replace the old sand in the bunker. Fifty-one tons of sand times an average price of $7.50 per ton will give us a cost of $382 for sand in that one bunker. This cost is for sand alone, with no labor included. If we were just going to add sand to that same size bunker and wanted to put in only 3 inches, the cost would be 1/2 of the $382 or $191 for sand only and no labor.

The cost of labor and equipment needed to remove sand from a bunker will run about $800 to $1,200 per day for a loader tractor and 2 dump trucks, if an outside contractor is hired. If sand is to be removed from a bunker, a crawler tractor, or at least a 4-wheel drive tractor is needed if you are going to get any production out of the equipment. A regular tractor loader that most golf courses have will do the job, but it will be slow and the tractor will get stuck many times. If you are just doing a couple of traps, then the course tractor could be used and the cost would then just be the man-hours of labor involved. But to remove sand from many bunkers calls for the more specialized and heavier equipment of outside contractors.

Two clubs in our area did extensive remodeling this past summer and early fall, and I do have some construction costs on sand bunkers that they were able to provide. The one club was charged $2.74 per square yard for the shaping and grading construction. The 4-inch perforated or non-perforated tile was quoted at $2.85 per linear foot. The installed price for 6 inches of bunker sand was $15 per cubic yard, including the labor to spread it. The finish grading, seeding, and sodding was charged at $2.95 per square yard.

The second club paid $150,200 for 29 bunkers that had a total area of 72,670 square feet. This figures out to be about 2,500 square feet per bunker, and the cost of construction for these bunkers came out to $2.05 per square foot. This figure includes 4-inch drain tile with an average of 50 feet per bunker, a filter fabric, pea gravel backfill over tile, and 6 inches of sand. Sod was laid all around the bunkers and out to a distance of 6 feet and all else was seeded.

Here again, I can't compare prices because the one club had no idea of the square footage of the bunkers. Also, the scope of work, the area the bunkers were in, type of terrain, all new construction, or remodeling are all different variables so cost comparison is hard to come by.

Many clubs are starting to use filter fabrics in lining their bunkers before placing sand in them. This prevents the sand from becoming contaminated from underlying soil. I have the cost of one club that kept records when doing one of their bunkers. The bunker size was 1,800 square feet, and 39 man hours at $5 per hour were figured for the following: remove the existing sand; re-contour to original outline; trench and tile; apply the fabric (terra bond); replace the sand; sod the banks; and clean up. The cost came to $542 in labor. They also figured in the cost of materials and equipment, which was $195, for a total cost of $737 for that one, particular bunker.

Many other clubs have used a filter cloth in their sand bunkers, but they didn't keep detailed records of labor and supplies. A typical roll that would be 300 feet long by 6 1/2 feet wide would cost about $196. This would come out to about 9 1/2 cents per square foot. For our average size trap of 2,120 square feet, the cost would be $201. The more you buy, the less the cost becomes when buying this product.

I feel that I have pretty much covered the costs of sand and grass bunker maintenance in the time allowed, today. For the most part, the surface was just skimmed when I discussed the cost of replacing sand and bunker construction. I hope I was able to make you more aware of the expense that these hazards cost us in maintaining our courses. Thank you for being such a good audience. And now I must get on back home to what really gets my attention this time of year.