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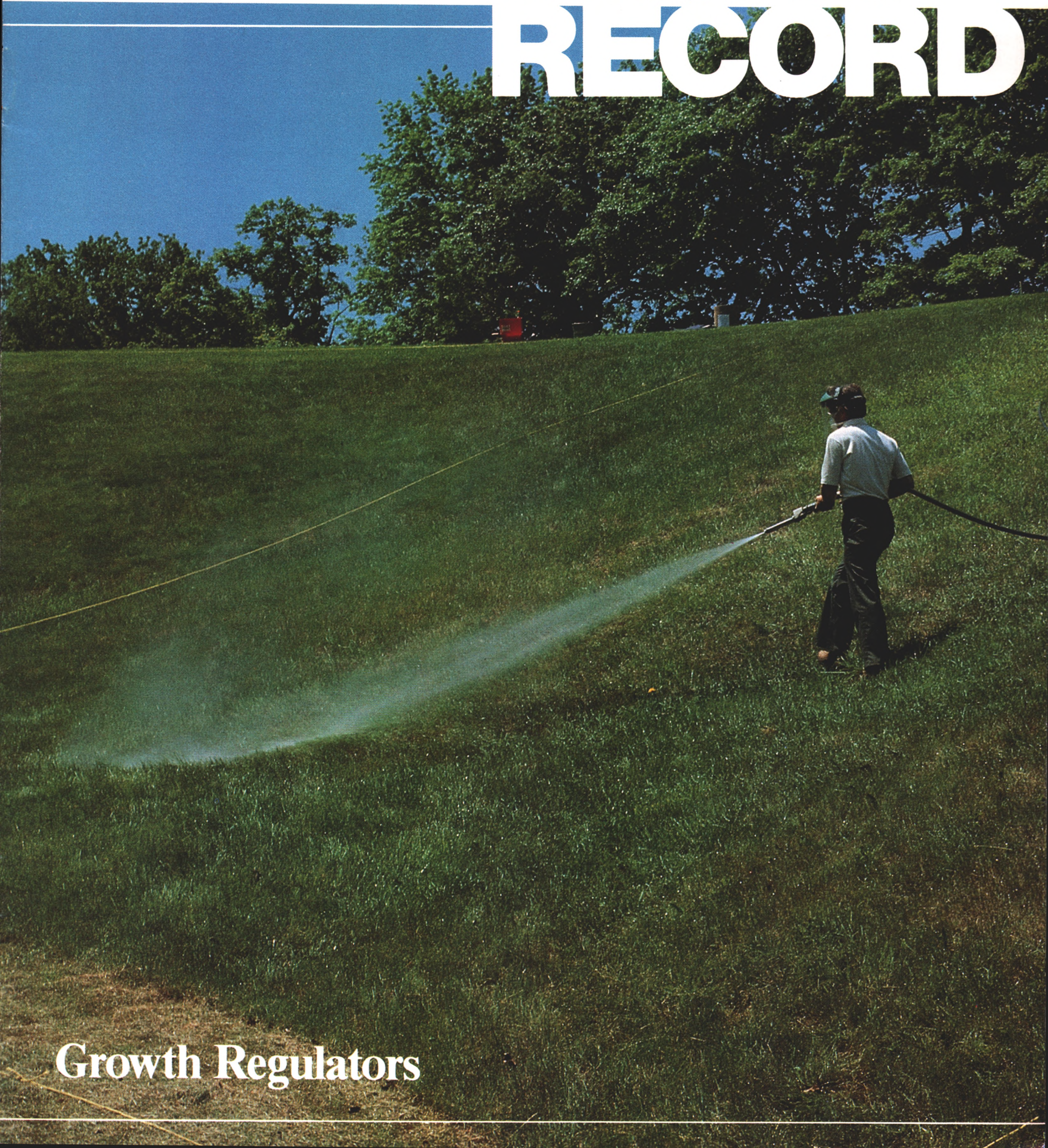

Growth Regulators

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Cover Photo:
Growth regulators will reduce the need for mowing dangerous slopes.

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Knowing how and when to use growth regulators can make a difference on your golf course.

Growth Regulators — New Tools for the '80s?

by STEVE M. BATTEN
Agronomist, Southeastern Region, USGA Green Section

GROWTH REGULATORS are not new. Almost 50 years ago plant scientists found they could actually change and often control the growth patterns of many plants by applying small amounts of certain organic chemicals. A new frontier had opened. It was an agricultural miracle that continues today.

In those early years, growth regulators were widely used to control broadleaf weeds on lawns and golf courses. Since then, gradually, subtly, scientists developed even newer compounds, and these are now capable of controlling the growth of grasses and landscape plants, chemical edging, seed head suppression, and retardation of not only broadleaf weeds but grassy weeds as well. Highway departments used them to suppress growth on embankments and steep slopes, and other commercial turf interests soon followed suit. But the acceptance of growth control agents on golf courses has been slow. Understandably, golf course superintendents have been reluctant to slow grass growth on the same general areas they are being paid to grow quality turf for golf.

Now, even that may be changing.

Continuing research, particularly during the last five years, has cleared the air for a better understanding of the limitations and effectiveness of growth regulators on fine-bladed turfgrasses. The trick to their successful use is in a basic understanding of their selectivity among grass species and their mechanical action on plants. In basic terms, this means the successful golf course superintendent should learn all he can about these new management tools and then put them to work.

Growth regulators can either stimulate or suppress shoot growth, root growth, or tillering effects of a plant. The most commonly applied growth regulators on golf courses are those that suppress shoot growth. These are maleic hydrazide (Slo Gro) and mefluidide (Embark). On the other hand, a growth regulator that stimulates vertical shoot growth is gibberellic acid. It had even been used to grow deeper rough in preparation for a U.S. Open Championship some years ago.

AS A GROUP, maleic hydrazide and mefluidide are often referred to as "growth inhibitors." This is because the turfgrass height is not altered during the period of suppression. In reference to the mechanics of action, maleic hydrazide and mefluidide suppress turfgrass shoots by inhibiting cell elongation.

More important than how they work, however, both are primarily absorbed by the leaves. In order to achieve the best possible inhibition, as much leaf surface as possible should be present at the time of application, and dead leaves and thatch should be removed. Timing of application, when the turfgrass is actively growing, such as in the spring, will allow for good translocation. Likewise, application after a rain or onto irrigated turfgrass will also improve translocation.

Scheduling of mowing prior to or after application can be critical. Because growth regulators are not instantly translocated, some manufacturers suggest mowing seven to 10 days after application in order to remove any flush of growth observed during the first week. This is especially the case with maleic hydrazide. Common sense should be exercised in not removing too much leaf material after application.

If the turf must be mowed prior to application, a good rule of thumb is not to mow any sooner than two days before the growth regulator is applied.

ALL OF THE growth regulators mentioned above can cause discoloration. For example, mefluidide has the ability to darken shoot color. Maleic hydrazide can cause yellowing. The effects of different growth regulators vary on different turfgrass species and on their cultivars as well.

Kentucky bluegrass discoloration is more likely to be apparent with maleic hydrazide than with mefluidide. Kentucky bluegrass also requires a much lower application rate of mefluidide than bermudagrass to get the same amount of shoot suppression. On the other hand, bermudagrass is more sensitive than bluegrass to maleic hydrazide. Furthermore, the fine-bladed improved bermudagrasses are usually more sensitive to growth regulators than the more coarse common types.

Discoloration can make a golf course superintendent humble if the chemical regulators are improperly applied to conspicuous turf areas. To avoid this embarrassment, first experiment with the suggested label application rate on an out-of-the-way area. Fitting the right growth regulator to your turfgrass condition can be accomplished simply by contacting a technical representative of the manufacturer. Then, one must be sure to apply the right material at the right rate to the targeted turfgrass species. Remember, these color changes depend on the turfgrass species and application rates, and you are in control of this operation.

AN EXPERIMENTAL group of growth regulators are presently being evaluated on warm- and cool-season turfgrasses. These growth regulators inhibit the formation of gibberellic acid in plants and thus suppress cell elongation. By governing the actual rate of plant growth, they are considered true growth regulators and not growth inhibitors. Their ability to suppress growth can be reversed by applying gibberellic acid. Therefore, they may become useful for manipulating different levels of retardation.

Two of these experimental growth regulators are paclobutrazol (PP 333) and flurprimidol (EL 500). EL 500 has been given the trade name Cutless.™ The main difference in these two and the growth inhibitors previously described is that they allow a continued but very much retarded lateral stolon growth. A distinct shortening of the internodes causes a witch-broom effect or multiple clustering of shortened leaves. It has even been noted that bermudagrass treated with EL 500 can have a more measured reduction in shoot height than that observed at the initial mowing prior to application.

Another difference is that these growth regulators are primarily absorbed by the roots. This could be a real plus on fine-bladed turfgrasses where granular formulation could be applied. In order to enhance root absorption, irrigation would also be necessary.

Although most species of turfgrass and landscape plants can be suppressed, there is a distinct difference in tolerance to PP 333 and EL 500 among species. Utilizing these tolerance differences, these compounds could be exciting new tools for managing weed populations and multi-species turfgrass sites.

The most common use of growth regulators at present is the reduction of mowing time on hazardous slopes. Some manufacturers suggest that mowing time can be reduced as much as 50 percent over a five- to eight-week period. Even though growth regulators are expensive to initially purchase, they do have great potential for saving mowing costs.

Another factor beyond cost is in equipment and personnel safety. There is no merit in exposing dangerous equipment such as rotary mowers to steep embankments any more than necessary. In this regard, much safer control of vegetation along drainageways or rough terrain can be possible.

Chemically edging the grass at the base of trees holds a great potential for growth regulators. If the proper application rate is used, the turfgrass will remain green and very acceptable for play. Another obvious advantage is less mower damage to the tree trunks. For this type of chemical edging, regulators should be selected that are primarily shoot and not root absorbed.

Within recent years, a great deal of concern has been given to chemically edging sand bunkers. Mefluidide has been successfully used for this purpose on cool-season turfgrasses. Several research studies are continuing at state universities for use of mefluidide alone, or in combination with EL 500. The objective of these studies is to increase the residual effects of shoot suppression.

SINCE GROWTH regulators are expensive, weed control is usually considered a fringe benefit. Realistically, weed control on areas where growth regulators have been applied is extremely important in order to maintain an acceptable appearance. Fortunately, many fast-growing broadleaf weeds such as white clover (*Trifoloum repens*) and oxalis (*Oxalis stricta*) are easily suppressed.

Rendering weeds to be less competitive is the basis for most weed control efforts with growth regulators. Research is being conducted on the timing of spring and fall applications of mefluidide and EL 500 in the northeastern United States for selective retardation of annual bluegrass in Kentucky bluegrass. On the other hand, in the Midwest, late spring applications of mefluidide at low rates have actually improved the summer vigor of annual bluegrass. Obviously, the timing of application and the rate

Characteristics of Growth Regulators

Commercially Available	Common Trade Name	Inhibition	Site of Plant Absorption	Comments
maleic hydrazide	SLO GRO (Uniroyal Chemical, Div. of Uniroyal, Inc.)	inhibits cell elongation and stops shoot	primarily shoot absorbed, some root absorption	for use on cool-season turfgrass
mefluidide	EMBARK (3M Agricultural Products, Div. of 3M)	same as above	primarily shoot absorbed	warm- or cool-season turfgrasses, bermudagrass required higher application rate than cool-season species
Experimental	**Experimental Number**	**Inhibition**	**Site of Plant Absorption**	**Comments**
flurprimidol	EL 500 (Cutless™) (Eli Lilly Laboratories, Div. of Elanco Products)	inhibits production of gibberellic acid and retards cell elongation	primarily root absorbed, some shoot absorption	presently being evaluated on both warm- and cool-season turfgrasses
pactobutrazol	PP 333 (ICI Americas, Inc.)	same as above	primarily root absorbed	same as above

applied can have an entirely different effect on weed control.

In California, kikuyugrass has been a target of growth retardation in bermudagrass turf. Altering turfgrass species by selective retardation has drawn considerable interest and opens the door to future research.

One of the most important characteristics of maleic hydrazide and mefluidide is their ability to impair flowering and seedhead production. This has led to their use in suppressing annual bluegrass in Kentucky bluegrass turf. Application rates of mefluidide for annual bluegrass seedhead suppression are less than half that suggested for suppression of Kentucky bluegrass alone. Thus, the manufacturer's recommendations this year will include annual bluegrass seedhead suppression. It is, in effect, a form of weed control.

Taking advantage of seedhead inhibition characteristics, many combinations of experimental growth regulators are constantly being tested for seedhead suppression on both warm- and cool-season turfgrasses. At Cornell University, an interesting study is underway to suppress annual bluegrass seedheads with multiple applications of Aqua-Gro, a commonly used wetting agent. The technique is patent pending, and the results are very positive to date. Other materials, including new fungicides with growth regulator properties are also being evaluated for seedhead suppression.

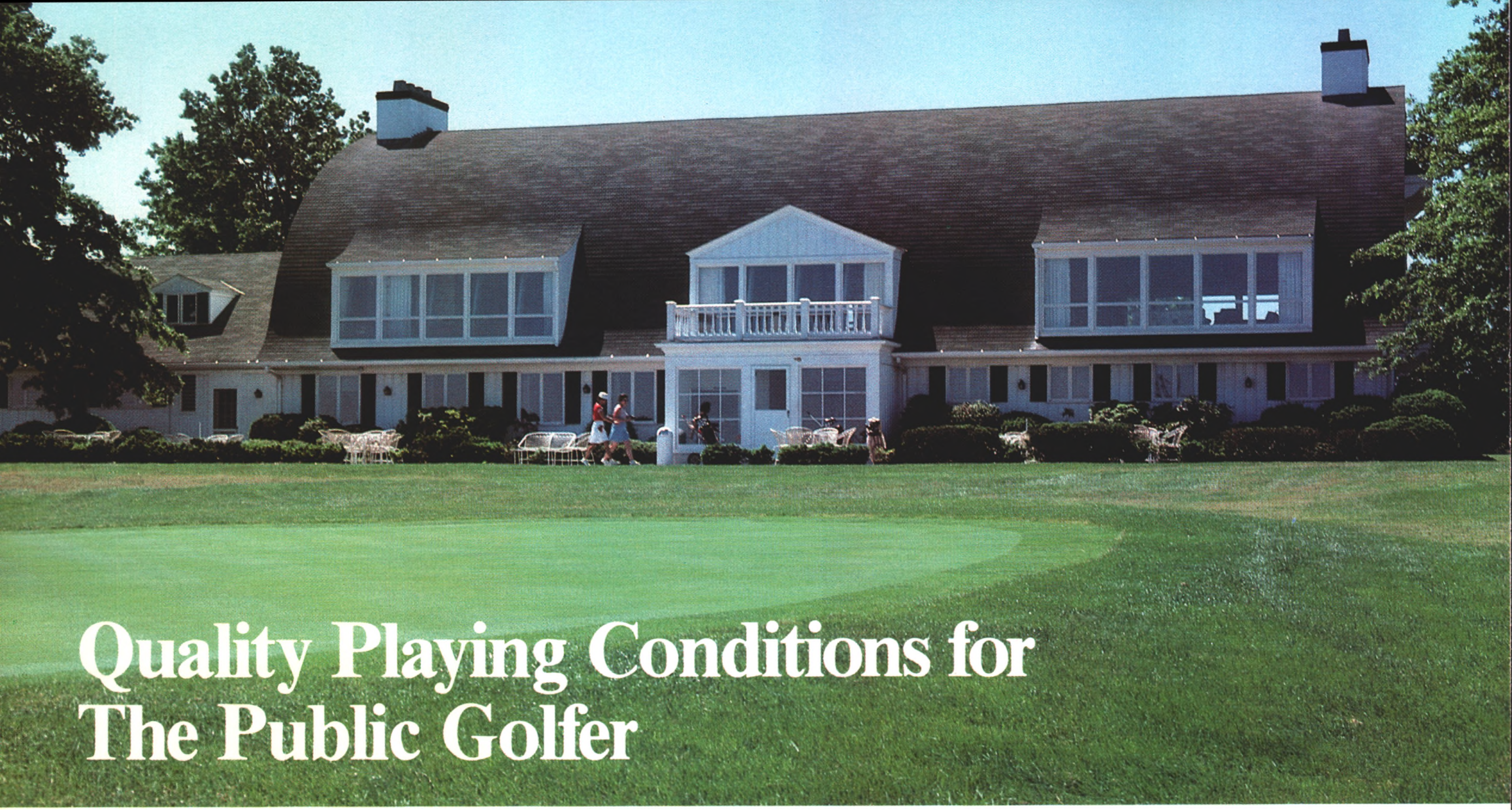
In Southern California, maleic hydrazide has been applied to bermudagrass fairways in the fall for shoot suppression prior to overseeding perennial ryegrass. Likewise on Kentucky bluegrass in the northeastern United States, mefluidide has been effectively applied prior to overseeding in the fall to renovate an existing bluegrass or ryegrass turf. In the Southeast/Southwest, the use of growth regulators prior to overseeding has also been suggested, and there does exist the possibility of spring applied growth regulators to aid in the transition zone in the southern part of the United States. Clemson University is investigating this approach and reports some success, although further investigations will be necessary.

Embark™ used for annual bluegrass seedhead control in Kentucky bluegrass.

RESEARCH HAS significantly increased during the last four years in regard to growth regulators and their effect on the physiology and development of turfgrass. For example, at North Carolina State University, evaluations are underway in regard to seedhead development and the effects of dormancy and root growth. Fertilizer interactions are being studied at Penn State. At Purdue, the University of Rhode Island, and Cornell University, the effects of growth regulators on annual bluegrass control and their effects on many other species of cool-season grasses are the main objectives of research. Across the Southern states, Auburn, Clemson, Mississippi State, Texas A&M, and the University of Florida have all taken interest and initiated studies on the new compounds that inhibit gibberellic acid formation.

Some of the most interesting research is being done with the new growth regulators and their effect on reduced water use in turfgrass management. Texas A&M University has been investigating EL 500 for this purpose on warm-season turf. Field studies are being evaluated with the use of weighable lysimeters (weighable containers) to determine water use rate. EL 500 has shown promise. In theory, PP 333 may also be used for this purpose, since its mechanics of action are very similar to EL 500. Interest has also been shown by several major northeastern universities to initiate similar research on cool-season turfgrasses. This concept of water use retardation may mean a new dimension for the use of growth regulators in the 1980s.

Research continues to open new doors to knowledge. Growth regulators are increasingly becoming management tools for the golf course superintendent. Now is the time to investigate these new tools under your conditions. Do it today. The experience and knowledge you gain will unquestionably find a place in your many tomorrows.



Quality Playing Conditions for The Public Golfer

The clubhouse at Hominy Hill, site of the 1983 U.S. Amateur Public Links Championship.

by STEVE FINAMORE, Superintendent of Golf Courses,
Monmouth County Park System, New Jersey

PUBLIC GOLF COURSES have always been considered to have lower turfgrass standards and poorer playing conditions than private clubs. Having visited, played, and worked on many private and public golf courses, it is interesting to note that a public course can provide both excellent playing conditions and beautiful aesthetic qualities. With adequate budgets and additional maintenance practices necessary for quality turf, the public golfer can and should enjoy playing conditions equal to his counterpart at the private level.

The Monmouth County Park System, in Monmouth County, New Jersey, owns and operates four golf courses open to the public. Two of the courses, Hominy Hill and Howell Park, are 18-hole championship layouts. Hominy Hill, selected in a magazine article as one of America's 50 Greatest Public Courses, will be the site of the 1983 U.S. Amateur Public Links Championship. It receives 45,000 rounds of golf per year. Howell Park receives 42,000 rounds per year. Both courses have unusual characteristics and provide golfers with conditions they can appreciate.

Greens at both courses average 7,000 square feet and tees between 4,000 and 5,000 square feet. Fairway turf has been reduced in past years through contour mowing efforts, and now averages approximately 23 acres for each course.

Maintenance practices are geared toward the heavy play that averages 230 golfers per day in June, July, and August, and 170 per day during April, May, September, October, and November. Before getting into any detail about our maintenance practices, it is worth mentioning the policies that have been approved by the Park System and have given us the opportunity to provide quality playing conditions. These policies have kept the courses from being run into the ground.

These policies include:

1. All play must begin on the first hole. With play beginning at 7:00 a.m. during the week and 6:00 a.m. on weekends, it would be impossible for us to provide quality work without this rule.

2. Golf cart traffic is limited to 50 carts per day, and carts are not allowed at all one day per week. This has been helpful in minimizing traffic and providing fairways that do not require improved lies for a good part of the season. No carts are allowed after 3:00 p.m., and carts are prohibited by the superintendent when conditions are unfavorable.

3. Courses are closed from December 15 through March 15 to avoid damage from play on dormant turf.

4. Green fees are set to reflect the type of budget needed to provide high-quality playing conditions.

In addition to these policies, mention should be made of the economics of the operation. The golf courses are financed through county taxes, but revenues exceed operating and capital expenditures. The operating budget for the maintenance of Hominy Hill in 1982 was about $230,000, which is comparable to many private clubs in the area. The crew averages four full-time employees in the winter and 10 during the summer.

Green fees at the four courses vary and are based on the respective maintenance budgets. At Hominy Hill, green fees in 1981 were $6.50 for county residents and $13. for non-residents. Golf carts are available for $13. Senior citizens pay $3.75 weekdays but must pay the regular fee on weekends. Revenue in 1981 for Hominy Hill from green and cart fees, concession and golf shop (both operated by the county) was $580,000, an average of $13. per round of golf.

As mentioned before, maintenance practices on greens, tees, fairways, and roughs are based for the most part on numbers of rounds played. To reduce compaction problems resulting from heavy play, it is important, I feel, that a cushion of thatch be provided on the playing areas. One-quarter inch is desired.

THE GREENS at Hominy Hill and Howell Park are about 95 percent Penncross creeping bentgrass. Four and one-half pounds of nitrogen are provided per year through a 22-0-16 fertilizer applied at .3 to .5 pounds nitrogen per 1,000 square feet every three weeks. During the summer, fertilizers are applied in early evening to discourage burn around cups from the 230 golfers we expect daily. Greens are mowed at 3/16 inch five times per week (Tuesday, Wednesday, Thursday, Saturday, Sunday). Greens are lightly topdressed monthly, aerated in June and September, and several problem greens are aerated an additional time in April. Straight sand or high-sand materials are used for topdressing to minimize compaction problems.

Verticutting lightly, to ensure a true putting surface, is practiced about two to three times per month. Verticutting to remove thatch is necessary on only certain areas of the greens. Though cups are changed daily and most of the green is utilized for pin placement, thatch buildup can be a problem around perimeters of greens and on collars.

Pests in our area include pythium, dollar spot, brown patch, leaf spot, cutworms, and grubs. A preventive disease control program is followed, and insecticides and herbicides are applied as needed. Wetting agents have been used for a number of years. They are applied as a granular or liquid monthly.

Collars are treated like greens, except they are cut at ⅜ inch three times a week.

The majority of the turf on tees is mixed bentgrass varieties. A few tees at Howell Park are bluegrass and a few at Hominy are ryegrass. The ryegrass has been used on two tees that suffer from a considerable amount of shade and do not hold up well with bentgrass. The condition of these tees has improved and overseeding with ryegrass will continue. Tees are mowed three times a week with a Greensmaster set at one-half inch and receive between 4½ and 5½ pounds nitrogen per 1,000 square feet per year. They are aerated in June and October, and several tees receive an additional aeration in April. A pre-emergence herbicide is applied in April and on certain tees in June after aerating.

Tee markers are changed daily and all the teeing area is used. Regular (white) markers may be located near blues (championship) or reds (ladies) on a given day, but the number of markers near reds will equal those near the blue to equalize the yardage of the golf course. The most important maintenance practice used on tees is the filling of divots with topdressing soil and seed twice weekly. From the time we open in March until Thanksgiving we rarely miss a week. This practice takes between two and four man-hours per 18 holes, depending on the number of divots. Verticutting to remove thatch is practiced on ladies' and championship teeing areas, which receive less play. Because of this, less fertilizer is also applied to these areas. Insecticide, fungicides, and wetting agents are used on a regular basis.

TURF ON FAIRWAYS at Hominy Hill is 70 percent bluegrass, with the remaining 30 percent a mixture of ryegrass, bentgrass, and *Poa annua*. Fairways receive 2½ pounds nitrogen per 1,000 square feet per year, are aerated once or twice per year (June and/or October), and are mowed at ⅞ inch four times per week (Monday, Wednesday, Friday, Sunday). Ends of fairways (toward tees) are aerated at least twice a year and are occasionally mowed with a triplex mower to compensate for damage from turning large mowing units in these areas. Approaches are mowed with triplex units only. Insecticides, fungicides, and wetting agents are used on fairways to keep turf healthy and pest free. Pre-emergent herbicides are applied in April for control of crabgrass.

Howell's fairways are predominantly bentgrass and are mowed at ⅝ inch three times a week (Monday, Wednesday, Friday). Fairways are verticut in April to remove excess thatch and are aerated in October. Two and one-half pounds of nitrogen per 1,000 square feet are applied per year, and insecticides, fungicides, herbicides, and wetting agents are used to ensure quality playing conditions. Approaches are mowed at one-half inch with a Greensmaster, and all approaches and fairways have been contoured to provide optimal playing and aesthetic conditions.

Wear areas around greens, tees, and between bunkers and greens present an added challenge to quality playing conditions. Because of traffic concentration, sides of tees are aerated three to four times a year with a fairway aerator. Fertilizer is applied at one-half pound nitrogen per 1,000 square feet per application from three to four times per year to these areas. Ballwashers, baskets, benches, and water coolers are moved each day with tee markers to keep areas alongside tees from wearing excessively. A Greensaire is used to aerate between sand bunkers and collars so that quality turf can be maintained. Pull carts, used by the majority of golfers, can cause stress on these turf areas. Wetting agents and fertilizers are also applied. Ropes, signs, and cart paths, all necessary evils, help us control wear around greens and tees. Ropes and signs are moved periodically so that wear is not restricted to one location. At the end of each year, the areas that do not recover from traffic, especially around the first tee and between bunkers and collars, are resodded.

Low cut rough or no rough at all, practiced on many public courses to speed play, can only hurt the image of a public golf course. The practice does not define the playing area and allows the ball to roll farther into trouble and away from greens and fairways.

I would like to touch briefly on another problem of concern to many of us in public golf. Public course players do not have the pride that private club members often have toward the golf course. Few days go by without seeing a golf cart going across a tee or riding inches from a green. Public golfers feel less responsible when it comes to repairing ball marks, replacing divots, and raking sand bunkers. Our biggest vandalism problem has been the golfer himself. Divots out of greens, clubs thrown through litter baskets and golf carts, golf carts running into irrigation control boxes and through sand bunkers; these are but a few of the situations we must deal with constantly.

EVEN WITH the large number of poor-quality golfers working against the public courses, I feel that with a reasonable budget, high standards, and a crew and staff who take a lot of pride in what they produce, quality playing conditions can be attained on public golf courses. Maybe someday the public golf course superintendent will not have to live with the words, "It's in nice condition — for a public course." Maybe someday, just maybe, he will hear, "This is a fine golf course and you have it in fine condition!" We hope so.

HOW TO:
Rebuild Eroding Bunker Faces

by STANLEY J. ZONTEK
Director, North-Central Region, USGA Green Section

HOW MANY TIMES have you read a magazine article only to find very little new information passed your way? I hope when you finish reading this one, you'll say, "Wow! Now there's an idea I'm going to try!" You see, this is a "how to" article: how to rebuild and improve the shallow, eroding faces of sand bunkers.

A fairly common problem on those golf courses that have the newer, shallower-type sand bunkers of more contemporary design occurs because, as originally constructed, these sand bunkers are radically different from the older, deeper and more classical bunkers with which we are familiar. The old style bunker design incorporated a relatively flat sand base with grass banks extending down to the sand.

The new style bunkers are much shallower (and even elevated for visibility in some cases) and have the sand extending or flashing up the bank. While this type of bunker design is attractive, quite visible and relatively easy and efficient to maintain, it does have some built-in maintenance problems. Foremost among them is erosion. *Diagram I* shows a cross section of this type of bunker. Water, whether from rainfall or irrigation runoff, travels down a grassy sloped surface, into the bunker, through the sand on the face and to the native soil underneath. When the water hits this tight, heavy native subsoil underlying the sand, it moves down the slope — carrying the sand with it and causing erosion.

Under normal irrigation or rainfall, little sand is moved. However, when heavy and intense rainfall occurs (as in thunderstorms), large amounts of sand can be moved off bunker faces, and the golf course superintendent and his crew have the chore of hand-throwing or pushing the sand back up the slope of the bunker. Besides being labor intensive, the sand readily becomes contaminated with subsoil, and it doesn't take too many of these washout/replacement cycles to badly contaminate and dirty the sand. This detracts from the appearance of the bunker. Also, this dirty sand has different playing characteristics, and dirty sand grows more weeds, too!

IT IS NOT my intent to compare or criticize different sand bunker designs. Rather, I would point out that there is a technique that can be utilized, within certain limits, to reduce maintenance and improve the appearance and playability of this type of bunker design.

Diagram II shows a plausible and practical solution to the problem. The underlying subsoil on the slope of the bunker is dug out and removed to form an approximate 90-degree angle between the bottom of the bunker and the edge of the hazard. In essence, a vertical wall is formed from two feet to four feet high. The sand is replaced, matching the original design and slope of the bunker. The process is then complete.

Figure I.

Figure II.

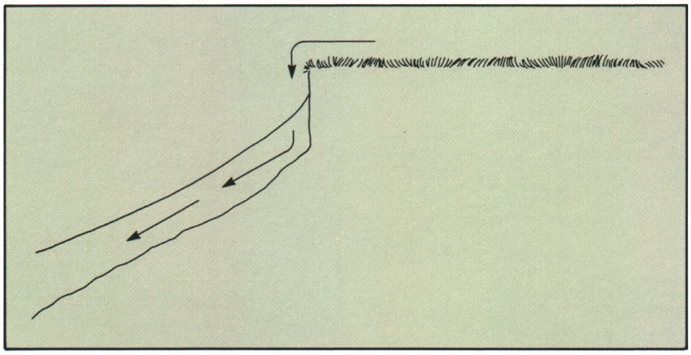


Diagram I.

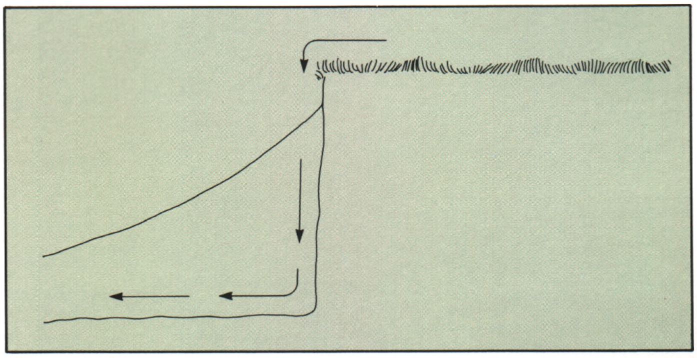


Diagram II.

Bob Holmes, Superintendent at Lafayette Country Club, Lafayette, Indiana, illustrates this technique during the renovation of some of the bunkers on his course:

Step 1 *(Figure I).* The eroding bunker face and its dirty and contaminated sand are removed mechanically, and the bottom of the bunker is leveled and squared off. To make the earth and sand removal quicker and easier, a small frontloading tractor is used.

Step 2 *(Figure II).* An employee is truing the cut and edge of the bank with a spade. *Figure III.* The finished job: a clean, neat wall ready for sand replacement.

Step 3 *(Figure IV).* The completed job with the sand replaced, smoothed and raked.

Bunkers constructed in this manner will look better and the sand will definitely stay in place better. This will reduce sand/soil contamination and alleviate the seemingly endless job of replacing washed-out sand after every heavy rainfall.

AS WITH ALMOST everything we do on a golf course, there are some limitations to this program. For example, there seems to be a limit on just how deep a cut can be made and how far the sand can be pushed up the face of the bunker. For one thing, this technique requires substantial amounts of sand, and the greater the elevation and cut, the more sand needed. Obviously, in areas where sand is expensive, this can become an expensive project.

Another consideration is that deep sand on the face of the bunker tends to be relatively soft and, under certain conditions, golf balls may plug and even bury on these faces. From a practical and playable point of view, there is a limit of approximately three to four feet on the depth of the sand. Within these limits, however, this procedure seems to work very well.

The old nagging problem of eroding sand on bunker faces now has a relatively simple solution. Where this rebuilding and renovation technique has been used, better looking and better playing sand bunkers have been built with resulting lower maintenance costs.

Now after all, isn't that what you were really looking for? A new idea that works!

Figure III.

Figure IV.

Exploration for Zoysiagrass In Eastern Asia

by J. JACK MURRAY and M. C. ENGELKE*

GENETIC DIVERSITY within a plant species is the hammer and nails needed by plant breeders to develop superior varieties. Considerable effort has been taken to collect and conserve genetically diverse germplasm of major crop species, such as wheat, barley, corn, soybeans, and forage crops. By comparison, little effort has been made to collect and conserve germplasm of turfgrass species. With a few and notable exceptions, representation of primitive and wild germplasm of turfgrass species in existing collections is scant, rarely representative of the genetic diversity that exists in the geographical center of origin of the species, and was probably collected by someone not familiar with desirable turf-type characteristics. Thus, the germplasm needed by breeders attempting to develop improved turfgrass varieties for the future is not readily available.

Interest in and concern about the current and future availability of genetic resources have increased in recent years. The reasons for this are many. The emphasis by turfgrass breeders today is focused on developing improved varieties with lower maintenance requirements in terms of labor and energy savings, and adaptability to adverse environmental conditions. This shift in breeding objectives, requiring genetically different germplasm, and the realization that many of the centers of germplasm diversity that have remained undisturbed for hundreds of thousands of years are rapidly disappearing because of population increase and land development. This has led to the general realization of the inadequacy of present turfgrass germplasm as well as the urgency to broaden its genetic variability by the collection and preservation of diverse germplasm.

The Research Advisory Committee of the USGA's Green Section recognized the need to increase the germplasm available for turfgrass breeding projects. They have recently been instrumental in providing funds for two exploration trips:

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A GREEN SECTION RESEARCH PROJECT

one to collect bermudagrass (*Cynodon* spp.) in South Africa (see article in July-August, 1982, GREEN SECTION RECORD) and one to collect zoysiagrass (*Zoysia* spp.) in Southeast Asia. We believe these are the first explorations made specifically to collect germplasm of turfgrass species. Hopefully, the Research Committee's initiative can be expanded to a cooperative global network with international participation for germplasm collection and conservation of the major species.

The authors submitted a proposal to the United States Golf Association and to the United States Department of Agriculture in 1981 for joint funding of an exploration of zoysiagrass germplasm to the Orient, where the species has evolved, i.e., its center of origin. Funding was approved by both organizations for travel in the spring of 1982. The trip began on May 14 and included about two weeks in each of four countries — Japan, South Korea, Taiwan, and the Philippines.

Samples were collected from as far north as 43°N latitude (equivalent to Milwaukee, Wisconsin) to as far south as 9°N latitude (equal to Panama). Samples of each of the three recognized species of zoysiagrass were collected, i.e., *Z. japonica, Z. matrella*, and *Z. tenuifolia*. Samples were also collected of two species identified in the Orient as *Z. macrostaycha* and *Z. sinica*. Samples of other grass species were collected, including bermudagrass, Kentucky bluegrass, bentgrass and fescues. The entire collection consisted of 421 samples from Japan, 261 from Korea, 53 from Taiwan, and 62 from the Philippines. All samples collected were shipped to the United States and are presently growing under greenhouse conditions.

PRIMARY EMPHASIS during the trip was to collect as much genetically diverse zoysiagrass germplasm as possible from diverse environmental niches. Many of the samples collected were existing in the wild with no fertilization or supplemental irrigation, under heavy traffic, close constant grazing, or modest to heavy shade. Samples were obtained from under seven inches of snow with good color, from salt beds, cattle and horse pastures, volcano craters, parks, cemeteries, and golf courses. Considerable differences were observed among samples in color, growth and flowering habit, leaf texture, disease resistance, and adaptability to low-maintenance environments.

Zoysiagrass grows wild throughout Japan. It was found as far north as Otura, on the northern coast of Hokkaido, the northernmost part of our trip (43°N latitude). Samples were collected from golf course fairways that had been overseeded with Kentucky bluegrass but remained about 50 percent native zoysiagrass. Along the southern coast of Hokkaido, samples were collected from unimproved range land being grazed by cattle, and along the seacoast. The soils in this area are coarse volcanic ash and droughty. The growing days are short, due to the northern latitude and frequent morning fog.

In the Hatochimatia mountains, in central Japan, we experienced subfreezing temperatures and approximately seven inches of snow at elevations of 3,000 to 4,000 feet. We randomly sampled zoysiagrass pastures at 150-foot intervals, as this area was totally under snow. Many samples appeared dormant, but a

(Above) The zoysias.

(Left) Collecting on Taiwan.

few showed definite green color. Considerable winter hardiness, drought tolerance, and fall color differences should exist among these samples.

In Tokyo we visited the grounds of the Imperial Palace, which have been in zoysiagrass since the 14th century. Numerous ecotypes were found having differences in foliar color and flowering habit. On the northwestern coast of Honshu, the main island of Japan, samples of zoysiagrass, bentgrass and tall fescue were gathered from water's edge to an elevation of approximately 75 feet. These plants experience considerable salt spray from the sea. On the southern island of Kyushu, collections were made in Cape Toi and from Mt. Aso. Cape Toi is a national wild horse refuge. The horses graze on natural zoysiagrass range. When zoysiagrass seed is eaten and passes through the digestive system of the horse, the seed will germinate. Zoysiagrass is one of the first species to establish itself on volcanoes following eruption. In the crater of Mt. Aso, considerable variability was observed in time of flowering and floral characteristics.

Golf is a very popular sport in Japan. Today, there are 1,400 golf courses, with 20 new ones costing $20 million each being opened each year. Courses are open year-round, except those in northern Japan, which open from April to early November because of severe cold and heavy snowfall. About 60 percent of the courses are using zoysiagrass greens and 90 percent zoysiagrass fairways and roughs. Specific zoysiagrass selections are being used on many golf courses. Selections are classified by their morphological characteristics or by names associated with area of production or origin. For example, the Tokyo selection is very popular for use on greens in the central region. There are no cultivars as we know them in the United States. This situation causes considerable confusion in classification.

WE VISITED 13 golf courses in Japan, several with members or staff of the Konsai Golf Union (KGU). The KGU is similar to the USGA Green Section in the United States. Numerous samples were taken from golf courses, greens, fairways and roughs. Some of these have been in cultivation for decades and express considerable differences in response to disease and insects, moisture stress, and management prac-

Emerald zoysiagrass on U.S. Military Cemetery, Manila, Philippines.

Zoysiagrass seedheads in a golf course rough, Japan.

Collecting zoysiagrass along a salt basin in South Korea.

Tombs in South Korea covered with zoysiagrass.

tices. In addition, we obtained cuttings from 15 accessions that the KGU has in their research program.

In South Korea, there are only 11 golf courses, eight of which have been constructed within the past eight years. Annual precipitation exceeds 67 inches and temperatures are similar to those of the transition zone in the United States. Bentgrass or zoysiagrass is used on greens, with zoysiagrass or bluegrass used on fairways and roughs. Zoysia was successfully established by seeding on several recently constructed courses. Plants appeared surprisingly uniform in newly seeded areas but quite different in leaf texture in older sod. However, this did not appear to be a problem on roughs or fairways.

Zoysiagrass is called golden grass in Korea because of its winter straw color. Selections are made for plantings based on shades of brown straw in the winter. There are many golden grass tea rooms and beer parlors. Koreans bury their dead in earthen tombs or mounds which stand approximately four feet above ground level. To hold the soil in place, these tombs are covered with zoysia sprigs. Over a period of time, the tomb is entirely covered with zoysiagrass. This procedure has become a ritual over the past several centuries. Many tombs have been planted to zoysias that were specifically selected for some agronomic trait — generally its winter straw color. A considerable amount of time was spent in surveying public and private tomb areas, and we collected many unusual samples. Few, if any, of the tombs received more than periodic attention, no fertilizer, and no supplemental irrigation. We located tombs established in 1200 A.D. of many of the early kings. Kings' tombs are 60 to 70 feet high and 800 to 900 feet in diameter. Most of the public tombs are 50 to 100 years old.

The most significant find in Korea was two additional species, *Z. macrostaycha* and *Z. sinica*, not previously worked within the United States. Samples were obtained of these species which existed primarily on the coastline and other high-salt areas, and rice paddy borders. *Z. sinica* appears to be more decumbent with a little finer and softer leaves than common *japonica*, but with larger seed and seed heads. *Z. macrostaycha* has an upright growth habit and appears stemmy. Although limited information is available, they are reported to be diploid species and not cross compatible with the three previously known species. This, of course, must be confirmed.

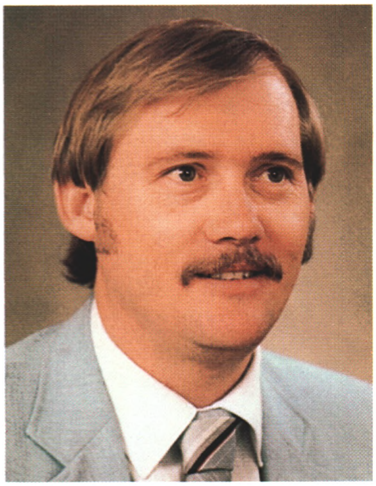
Kansai Golf Union Research Center near Kobe, Japan.

In Taiwan and the Philippines, zoysiagrass was more difficult to find in the wild as well as in cultivation, and diversity was less than in Japan and Korea. Cultivated turf in both countries is principally zoysia and bermuda. Northern and southern coastal areas and elevations up to 4,600 feet were surveyed in Taiwan. Zoysiagrass was not found at elevations above 2,000 feet. Several samples of *Z. matrella* and *Z. tenuifolia* with considerable diversity were obtained from coastal areas. *Z. japonica* was not observed further south than northern Taiwan. Several samples of *Z. tenuifolia* were collected from coral reefs on Orchid Island, located off the southeastern coast of Taiwan. During high tide these reefs are completely submerged. The island is inhabited by an estimated 2,000 aborigines without the conveniences of modern life. The genetic diversity observed in Taiwan is well represented among the 53 samples collected.

WE IDENTIFIED and collected a unique zoysia genotype in each major geographic area of the Philippines. On Cebu Island we found primarily *Z. matrella* on the edges of saltwater fish tanks and on the seacoast beaches. Even though few lawns or other areas of cultivated turf were evident throughout the country, those that we found are of a fine-leafed *Z. tenuifolia*. However, they were usually thought to be bermudgrass by the Filipinos. The U.S. military cemetery in Manilla has about 460 acres of emerald zoysiagrass. The original plants were obtained from the Beltsville Agricultural Research Center, in 1953. The cemetery grounds are verticut and fertilized once a year. Although the turf was relatively thatchy, it was beautiful and provided excellent turf.

We feel the genetic diversity of germplasm contained in this collection will provide the industry with the wealth of diversity needed to develop improved turfgrasses for future generations. The diversity observed among the zoysia species was much greater than we had anticipated. We look forward to having the opportunity to assess selections collected and to identify superior genotypes. This will require considerable research over an extended period of time. A few superior genotypes might be sufficiently adapted and perform well enough to be released as new cultivars. If not, they may be a source of germplasm for hybridization.

News Notes for Summer 1983



Karl Ed Olson

Karl Ed Olson Named Green Section Agronomist, Northeastern Region

Karl Ed Olson, golf course superintendent at Ft. Douglas/Hidden Valley Country Club, in Salt Lake City, Utah, has joined the staff of the USGA's Green Section. He replaces **Brian M. Silva**, who resigned last winter to pursue a career in golf course architecture.

Olson will serve as agronomist in the USGA Green Section's Northeastern Region, assisting Regional Director **Jim Snow**. His office will be in Worcester, Massachusetts, and he will be responsible for visiting USGA Member Clubs and courses in Maine, Vermont, New Hampshire, Massachusetts, Rhode Island, and Connecticut.

Karl joined the USGA staff in May. He is 33 and a graduate of New Mexico State University, where he earned a bachelor's degree in agronomy and was a member of the university's golf team. He is a Class A GCSAA member and, for the past eight years, the superintendent at Ft. Douglas/Hidden Valley Country Club, Utah.

His turf management experience also includes positions at the Orinda Country Club (California), the Four Hills Country Club and the University of New Mexico golf courses, in Albuquerque. He has a wide range of technical and practical experience, from university research to golf cart and maintenance equipment mechanic. We are most fortunate to have his experience on our staff.

Tim Ansett Resigns

Timothy G. Ansett, Western Region Agronomist of the Green Section, announced his resignation from the staff on April 15, 1983. Tim had served USGA Member Clubs from coast to coast since coming to the USGA in the summer of 1980. His future plans are indefinite although some world travel is a consideration. His many friends in golf and turfgrass wish him well.

Golf Shoe Study Underway

With the advent and active marketing of the rubber, multiple-stud-sole golf shoes in recent months, the Green Section has undertaken a study to evaluate the effect of two types of these shoes on turfgrass quality, wear, injury and putting quality. Two other types of golf shoes (the conventional metal-spike golf shoe and one of the new spikeless, lightweight golf shoes) are also included in the study.

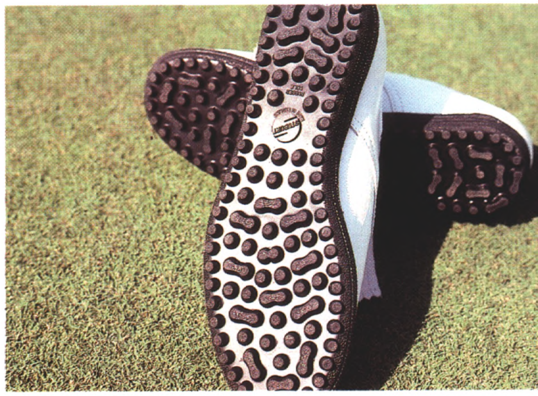
The experimental plan was developed for the Green Section by **Drs. V. A. Gibeault** and **V. B. Youngner** of the University of California, Riverside, and is being carried out at Industry Hills Golf Course, Industry, California. The experiment will be completed in mid-June. Statistical data and conclusions will be developed and published in the GREEN SECTION RECORD at the earliest possible date.

The Green Section has long held an interest in turfgrass injury and wear caused by certain types of golf shoes. Extensive experiments were carried out in 1958 and 1959 and the results published in Green Section publications of those years.

Conventional Spike.

Multi Studs #1.

Spikeless.



Multi Studs #2.

USGA GREEN SECTION RECORD
MAY/JUNE 1983

TURF TWISTERS

IT'S A GREAT FEELING

Question: With so much controversy over the Stimpmeter in the USA, I can't help wondering what superintendents in other countries must think about it. Are there Stimpmeters abroad and, if so, what reactions have you heard? (Washington)

Answer: Stimpmeters have been sent to many different countries (England, Japan, New Zealand, Australia, South Africa, to name a few) and the reaction has been most favorable. Writes an Australian superintendent recently, "It is a great feeling to know exactly what speed your greens are and be able to compare them with others in the world." In most other golfing nations, the playing surfaces are usually firm and dry. Their limited irrigation and fertilization practices create putting speeds which high budget dollars alone cannot produce. Our Australian friend reports normal playing speeds of 9 feet 6 inches on his course and up to 12-foot ranges for a recent major championship!

GETTING THE BEST RESULTS

Question: How should I properly sample any sand pile to obtain one gallon of sand for laboratory testing purposes? (Texas)

Answer: Proper sampling is one of the keys to success. It is extremely important to get a uniform sample of any sand, soil or soil mix for the laboratory work. Always sample at least a half dozen locations in the pile, regardless of its size. A soil probe stuck into the pile and then emptied into a clean container from numerous locations is one excellent method. Avoid sampling from the very bottom edges of the pile where the coarser material tends to accumulate. The more sub-samples you take to fill your one-gallon requirement, the better the test results will match the results you will get from the material.

FROM FIRM GREENS

Question: I would like to keep my greens firm like the USGA recommends, but I am continually getting complaints that the greens won't hold. What can I do? (Virginia)

Answer: 1) Educate your crew, the pro, and the green committee. The greens are not supposed to hold; the golfer is responsible for making a good enough shot so the ball will spin and stop on the green. 2) Make an effort to improve the playing quality of the fairway by maintaining a firm, closely mowed surface. If close mowing (less than one inch) is not possible, mow the fairways more frequently.