

MAY 1968

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association





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Cover Photo: Putting green construction in another era. This photo is more than 50 years old. The twenty men in this operation are involved in a laborious undertaking. Many putting greens built prior to World War I are still in use. Modern requirements are more stringent and modern construction methods are more efficient, but the principles involved remain unchanged.

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Greens which support a dense turf growing in a properly prepared seed bed mixture are resistant to pitting and foot printing even when adequately watered.

Evolution of a Putting Green

by MARVIN H. FERGUSON

Recently an inquirer requested information regarding the depreciation rate of a putting green. Obviously, the person was concerned with a privately owned golf course operated for profit, and he wanted to know how soon a golf green can be expected to wear out. He was told that some of the fine putting greens on old courses had been in existence for many years, and were now as good or better than they were in the beginning.

Our caller persisted. Aren't there many clubs which are rebuilding greens that have been in existence only a short while? He was told that this is, indeed, the case. Then why did these greens wear out? What is the criterion by which life expectancy can be predicted?

He also asked if present day traffic loads were not causing obsolescence of greens which may have been satisfactory in the days when golfers were fewer. We answered that this is

true. Some greens become obsolete because of a change in demands made of them. Others might be labeled obsolete the day they are completed because of unsatisfactory construction.

By learning from the experiences of others, by inquiring into the fundamental laws of chemistry and physics, and through an understanding of the physiological phenomena governing the behavior of putting greens, we have made some progress in the matter of putting green construction.

The first serious efforts to determine optimum physical characteristics of soils for putting greens were undertaken by the USGA Green Section in 1947. Through arrangements with Saratoga Laboratories of Saratoga, N.Y., studies were made of the textural composition of "good" and "bad" greens from numerous golf courses. Unfortunately, the studies provided few clues to



A conference group discusses putting green construction and studies a model in the foreground. The thought provoking nature of the discussion shows in the faces of the audience.

explain why one green supported better turf than another.

In 1951 the author had the opportunity to work with a group of civil engineers engaged in paving work, and became acquainted with some of the criteria upon which they judged the suitability of base material for the support of pavement. Their aim was **density** and **stability**. The aim in a putting green soil is to achieve a degree of stability, but certainly not density.

One of the measurements used by the engineer is called the plasticity index. Obviously, plasticity of base material is inimical to support of pavement. Charts are available which indicate the amount of granular aggregate material necessary to stabilize soils of any given plasticity index. It occurred to us that a similar chart might be constructed which would show the percentage of a given soil which could be used if sand and organic matter were of a specified type.

Raymond Kunze embarked upon a period of graduate study at Texas A&M in 1953, and he chose this subject for his thesis work. As might be expected, the problem turned out to be more complex than it appeared.

Kunze collected cores from putting greens, determined density, made textural analyses and

recompacted the material to its original density. He then studied the particle sizes of sands and their influence on turf growth and compactibility. He found that sand particles of fairly uniform size in the range of .5 mm. to 1 mm. were preferable, but securing such uniformly graded sand was generally too expensive to be practical. Some sources provide concrete sand or mason's sand which will serve the purpose satisfactorily. However, one must select carefully because there is much variability in such products.

Kunze also worked with different types of clay. He found that much more kaolinite clay could be used than montmorillonite. Montmorillonite is a highly plastic clay that tends to envelope and cement the sand particles.

A great many mixtures were made up and studied with respect to their ability to support growth under conditions of close mowing and compaction. One interesting observation was that the mixture containing the least sand and the most soil supported the most vigorous turf at the outset. However, as compaction was imposed, the response became completely reversed, and those mixtures containing the greatest amount of sand and least soil were most vigorous.

In 1956, Leon Howard began work toward his Master's degree and he continued Kunze's work. Howard used many different soils and sands, and compared these in field plots and in the laboratory. He found that variations in sand or in soil could be tolerated so long as the mixture produced some common measurable physical qualities in the end product.

He found that in general after compaction, the non-capillary (large) pore space should amount to 12 to 18% of the volume. Capillary (small) pore space should range between 18-27%. Hydraulic conductivity, according to Howard should range between .5 and 1.5 inches per hour. (Note: It has been found that in practice, the upper range is preferable.)

In the meantime, other workers had contributed to the literature, and attempts were made to incorporate these findings into the work Kunze and Howard had done. W. L. Garman, working in Oklahoma, had observed that about 20% of peat, by volume, was the maximum desirable amount. Richard Davis at Purdue and Ray Lunt at ULCA had found that most compaction occurred very near the surface of the soil. Lunt had tried building some greens, using a layer of pure fine sand about 4 inches thick over the existing soil. Such greens were satisfactory, but watering had to be done very carefully.

At about this time Reese Coltrane, superintendent of Lakewood Country Club in New

Orleans, built a pitching green using a porous soil mixture on a base of muck from Lake Pontchartrain. The green was almost impossible to keep because the muck pulled moisture from the porous soil mixture very rapidly. Obviously, some way of interrupting this capillary attraction was necessary.

We also learned during this period that Willie Tucker, who was one of the pioneer golf architects in America, used a layer of gravel and manure at a depth of about 9 or 10 inches in greens he built at the University of New Mexico in Albuquerque.

We assumed the gravel was for drainage, but could not understand the purpose of the manure until Mr. Tucker told us that the layers were not necessarily for drainage. They simply broke up the capillary pathway whereby salts from the caliche subsoil crept to the surface. The manure layer above the gravel was Mr. Tucker's way of preventing soil particles from migrating downward and filling the spaces between gravel particles.

We had long been aware of the detrimental effects of texturally different layers near the soil surface, and it had become apparent from the observations cited that layers could be made to serve useful purposes if they were placed deeper in the soil profile. This thinking was reinforced when Charles Wilson brought to our attention some of the demonstrations of Walter Gardner, at Washington State University. Gardner has shown in a dramatic way the effect of

Good design, good construction, a well chosen grass, and adequate maintenance contribute to near perfection on some of the modern putting greens.





The Arlington Turf Gardens provided the site for testing many of the putting green grasses now in use. The grass in this picture is the original test plot of Arlington (C-1) creeping bent

layering upon water movement through the soil.

The many bits of information from various sources finally began to permit their fitting together into a concept of putting green construction. In 1957 and 1958, Leon Howard rebuilt the greens at Texarkana Country Club using the method we had devised. In 1958, he rebuilt the greens at Albuquerque Country Club. None of these greens has ever experienced serious trouble. They have been relatively easy to keep, and they continue to be in good condition.

By 1960 we felt we had enough information to publish an article entitled "Specifications for a Method of Putting Green Construction." The method is described in detail in the September 1960 issue of "USGA Journal and Turf Management." An article outlining progress and re-defining these specifications appeared in the "USGA Green Section Record" in November 1965.

The articles were controversial. Some people automatically rejected the concept because it emphasized the use of a large proportion of sand, and these people thought the sand content was too high. Others argued that the information available did not justify the advocacy of the method. This view has some justification, but it is a philosophical matter to decide when to publish information which one thinks is an

improvement. Inasmuch as it is not practical to declare a moratorium on green construction until the ultimate answer is found, we chose to publish the information available because it appeared to be better than anything previously recommended.

It is our feeling that time has justified our position. The method has proved to be workable under almost any condition. Furthermore, the very fact that the recommendations were controversial has stimulated a great deal of research.

There have been some problems with greens which were purportedly built by these specifications. Most of the problems came as a result of failure to follow directions. One club did no mixing, but simply placed the various components in layers, one on top of another.

One builder used tile in the subgrade base—glazed tile with the bell joints cemented. Obviously, this person lacked an understanding of the manner in which tile works.

A third club built the greens correctly, but sodded them with bentgrass sod grown on a muck soil.

While it is difficult to comprehend the reasons for such errors, the mistakes are so obvious and such serious blunders that one does not worry too much about their being repeated.

Less obvious mistakes, and therefore more likely to occur, are such things as borrowing a neighbor's formula and applying it to soil materials that may be quite different; failure to include a buffer layer to keep soil from migrating into the gravel; leaving out the gravel layer; leaving out the tile; or otherwise taking a short cut that may negate the entire concept of a Green Section green.

There are sometimes problems concerned with learning to water adequately. Learning to fertilize such a green may be the source of some difficulty. There are some legitimate complaints of hard greens when they are first constructed, but this complaint is not very frequent. Grass is more difficult to establish on a sandy soil and this is the source of some complaints.

There is still much to learn about putting green construction and it is gratifying to see a great deal of research effort being expended on the matter. As new information becomes available we shall be able more nearly to approach a trouble-free putting green. It is an evolutionary process that will come about through the piecing together of many bits of knowledge.



The cart path, leading from the tee, immediately runs across the fairway at approximately right angles.

Golf Carts Traffic Control and Twelve Months of Grass

by HERBERT B. PRATT, Green Chairman, Rancho Santa Fe Golf Club,
Rancho Santa Fe, Calif.

Power golf carts are relatively new to golf. In a very short time their use has changed from the "medical case" to one of convenience. Many arguments are presented that golf is a game of exercise—you should casually walk up to your ball, studying the terrain, possible line of flight, distance, and maybe even enjoy the scenery between shots. However, many golfers today could not comfortably play without the use of a cart. In spite of the pros and cons, golf carts are very much a part of the maintenance problem. Who has ever seen grass grow on a freeway?

The Rancho Santa Fe Golf Club is located in the center of a residential area thus making it practical to use the golf cart as a second automobile for transportation to the course. As a consequence, we have approximately 70

privately-owned carts and 40 club-owned carts. Many of our residents are retired, or if not retired, have the time to play a lot of golf. Many of the privately-owned carts are used by the husband Monday, Wednesday and Friday, his wife Tuesday and Thursday, and perhaps by both of them on the weekend.

It's a great life, but it presents problems in golf course maintenance. How do you eliminate mud holes at every entrance and exit? How do you disperse carts so that paths are not worn in the fairways? How do you get cooperation from your members to save the course as much as possible? You don't solve all the problems, but it is possible to improve the situation.

At Rancho Santa Fe it was definitely decided not to have continuous paths around the course.

It would detract from our country atmosphere and slow down play if the cart was left on the path while the players walked to their ball.

ON THE TEE

Several years ago an article appeared in one of the golf magazines suggesting that, rather than have cart paths straight out from the tees, it would be better to have them turn at a sharp angle and run across the fairway in front of the tee. It was thought that a person naturally stays on a path, that he would suddenly realize he was going the wrong way and turn off towards the green.

The different reaction times of various persons would cause them to make their exits at different places which would disperse the wear at the exit point of the path as well as create different patterns of travel over the fairway. This system could be successful at a resort type course that is not played by the same golfers all the time.

After careful study, but with the above design in mind, it was decided to have small, easily moved, portable signs with an arrow

placed on the path to force an exit at that point. At the start of the path, signs were placed to "Exit at Arrow." The sign on the path is moved daily by the may who changes the tee markers. If the path is, say, 70 yards long you can use 10 yards for an exit, which means an exit is used once a week and has six days to recover.

While you never get 100% compliance, we feel that perhaps eight out of 10 golfers are most anxious to cooperate. By having the path run across the fairway at right angles, traffic is also distributed on the fairway itself.

AT THE GREEN

The paths at the green present a different problem. It is vitally necessary to have them because all traffic finally concentrates there. Our general plan is to have a paved path from the green to the next tee. It is obvious that the entrance problem is different for the green paths. You cannot have a path across the fairway in front of a green, nor can you use the same entrance system as the exit system on the tee paths.

To solve the problem, we have constructed

The arrow "Exit" sign is moved daily on each path. Perhaps 8 out of 10 golfers cooperate in distributing the wear.



paths in the rough, parallel to the fairway, and about 70 yards in front of the green. These same paths continue to the next tee. Small portable signs saying, "Enter Here" are placed on these paths and moved each day. This solves the problem of giving the grass a chance to grow at the path entrance, but it does concentrate traffic from the fairway. However, by varying the entrance daily, it seems to save the fairway somewhat, and we do not have any serious problem with cart wear.

PATH CONSTRUCTION

The construction of cart paths varies with the availability of local materials and soil conditions. Rancho Santa Fe has a heavy clay soil which requires a six-inch excavation, filling with four inches of decomposed granite, and then paving with two inches of asphalt. Asphalt is not an ideal material because it deteriorates with water, and you do have water on a golf course.

There is considerable maintenance in patching spots that break off, etc. It is difficult to find a suitable material, except concrete, but the cost of concrete is prohibitive.

If a well-groomed look is desired, it is best to use two-inch headers on the borders of the path. This also helps the edges from chipping off. Since this adds considerably to the cost, we did not use them at Rancho Santa Fe. After the path has been completed and the grass established along the edges, it presents a fairly neat appearance without headers.

ABOUT THE AUTHOR

Herbert B. Pratt has been Green Chairman and Board Member at Rancho Santa Fe Golf Club, Rancho Santa Fe, California, since 1964. At a club with over 100 electric carts in constant use, 12 months of the year, he has had to deal with traffic and grass. A graduate of the University of Southern California, Mr. Pratt has been an active golfer for the past 15 years.

Most of our paths are five feet in width. This should be considered minimum. If the budget is adequate, we would suggest a width of six feet. A golf cart can use a path four feet wide, but it takes effort to stay on it and carts riding the edge cause the edges to chip off. If necessary, it is recommended to reduce the number of paths and make them six feet wide. There are locations on the course where it becomes essential to use the paths to move maintenance equipment as well. In these locations, the width should be a minimum of 10 feet.

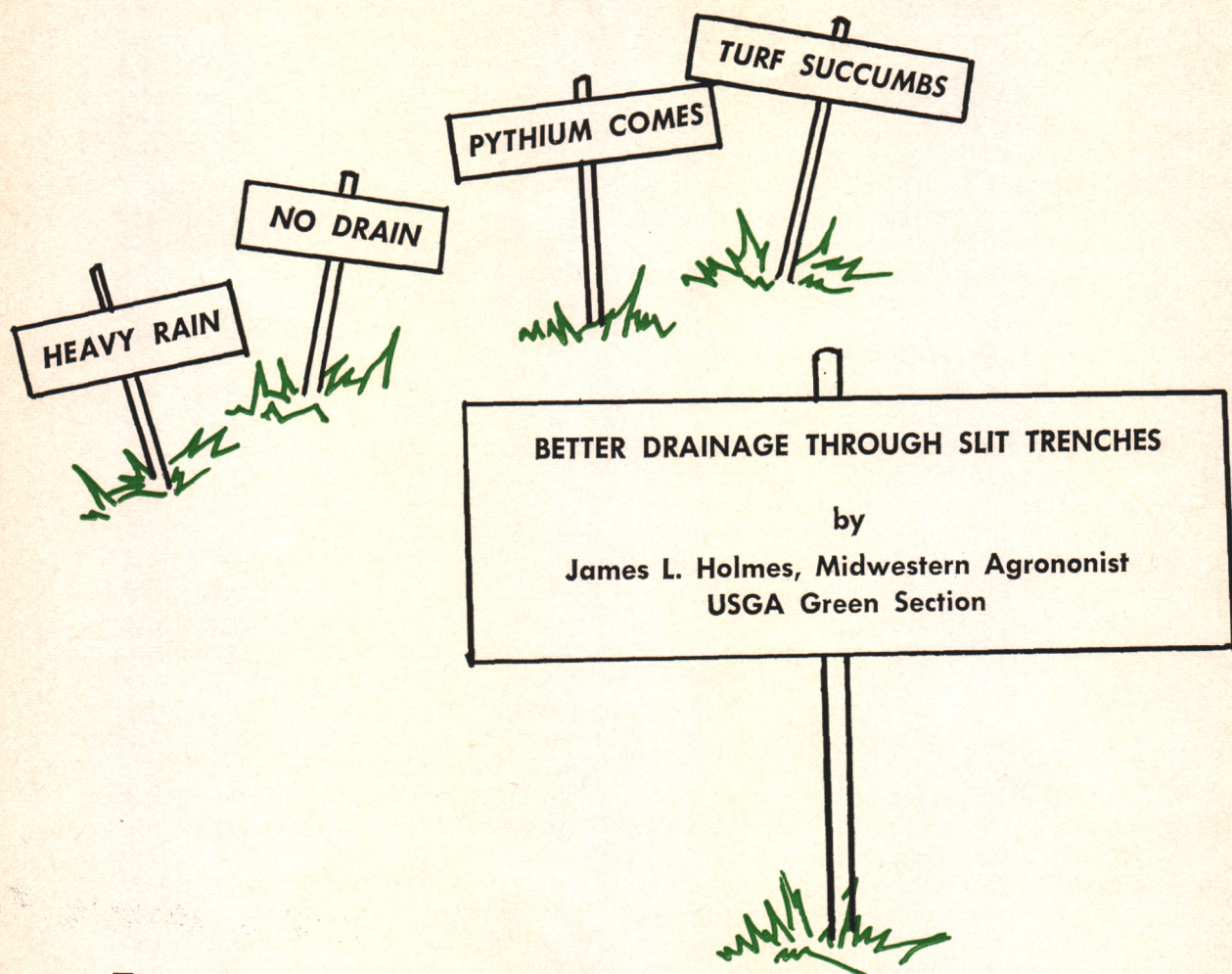
It is difficult to work out the exits and entrances for paths on par-3 holes. At Rancho Santa Fe we have solved the problem with continuous paths from tees to green on all par-3 holes.

PATH MAINTENANCE

After installation of paths, it is important to have a definite program for their maintenance. If they are of asphalt, they should be resealed perhaps every two years, and any holes or cracks should be filled. Water under an asphalt path causes it to break up, particularly when the soil is heavy and drains poorly.

While all the problems have not been solved, and probably never will be, we are quite happy with the general plan to handle traffic at Rancho Santa Fe. Cart traffic is incompatible with the growing of grass, but it is our hope that our experience here will prove helpful to those who still have the problem to solve.





To my knowledge, Roy Nelson, golf course superintendent of the Ravisloe Country Club in Homewood, Ill., was the first man to develop the open slit trench method of surface drainage. About eight years ago Roy and his crew were digging slit trenches in low, water-holding areas which they planned to fill with pea gravel to within four inches of the soil level, and then fill the remainder with soil and place sod. After the trench had been dug and pea gravel installed, a hard shower developed, and the crew sought shelter in the maintenance shop.

Upon returning after the rain, Roy noticed that the partially gravel-filled slit trenches had immediately received the water and the low, water-holding area where the trenches were being placed was completely drained. As a result, Roy decided to fill the trenches completely to the surface of the soil with pea gravel and observe if turf would grow over the pea gravel.

Within about three weeks, turf had grown over the gravel slit trenches and they continued to accept surplus surface water readily, thus facilitating surface drainage.

Now, eight years later, these trenches have not "dirtied-up," and they continue to accept surplus surface water readily. However, such trenches cannot be dug in bare or non-turfed soil because they will seal from soil movement or erosion effects. Roy estimates that at present he has in excess of 20 miles of slit trenches at Ravisloe, and has effected rapid and adequate surface drainage. Prior to this time, it had been simply impossible to "surface drain" the terrain at Ravisloe, and each year large areas of fairways were lost as a result of standing or puddled water. This was true even though a complete herringbone subterranean tile system had been installed and was in place for a number of years.

Since this time, practically every golf

course I have visited has installed open gravel slit trenches.

The reason for leaving the gravel-filled slit trenches open to the surface of the soil is really quite simple. The principle involved here has been recognized for a number of years. If any amount of soil is placed over gravel, not only do the smaller soil particles fill or seal the interstices of the gravel, but they also act as a blotter or sponge above the gravel, and quite effectively keep water from entering as rapidly as necessary.

To date all such trenches have been dug to a depth of approximately three feet and three inches wide. This is so because equipment for digging such trenches is designed this way. It is possible that a slit trench one inch wide would be effective.

If slit trenches can be placed over tile or extended into a natural drain-off, so much the better. However, this is not absolutely essential because slit trenches running through low, water-holding areas, and without an outlet are still effective in encouraging rapid surface drainage. This is no doubt due to considerable water being absorbed through the bottom and sides of the trench.

Even though subterranean tile is in place, water movement down through soils high in silt or clay content is impeded, and such tile cannot remove surface water fast enough to guard against turf "cook-out" during stress periods. The simple installation of gravel-filled slit trenches has circumvented, or negated the necessity of placing tile in many locations. Obviously, if a large, low, water-holding area is

in question, it is helpful, perhaps even necessary, to place at least one tile through the area for complete carry-off. When this is done, herringbone pattern slit trenches can be run from this tile into low pockets or water-holding spots.

We have found that pea size is the most effective type gravel. It tends to stay in the trenches better. Further, in locations adjacent to greens or other "landing" areas, many superintendents place four or five inches of a calcined clay material over the gravel. This prevents club faces from being damaged. The turf grows over or covers calcined clay somewhat more rapidly than it does gravel.

As the years pass, we have found that more superintendents are depending on slit trenches to insure a rapid surface drainage. Indeed, at many courses it was impossible to maintain a healthy turf on certain fairway locations during July and August. As an example, the picture of Al Bunn standing in the low fairway area where slit gravel trenches run off into the creek has made it possible to maintain a suitable turf here.

Prior to slit trenching, the grass constantly had "wet feet." Of particular interest, this area had been completely herringbone tiled for a number of years, the tile emptying into the drainage ditch. Even so, it was impossible to keep a healthy turf in July and August following heavy summer rains. This is just one of the many examples in the Midwest where slit trenches have completely solved a surface drainage problem.

While calling at Somerset Country Club in St. Paul, Minn., two years ago, Gerry Murphy,

Use of chain saw (left) is convenient way to make tiny slit trenches in green. Fairway slit trenches (right) are wider and deeper.





Bill Madigan of Forest Lake Country Club in Detroit (left) stands amid "herringbone" slit trench design on one of his greens. Al Bunn, Illini Country Club, Springfield, Ill., (right) shows slit gravel trenches draining into a creek from low fairway area

golf course superintendent, pointed out small slit trenches he had placed on the putting green in an effort to drain low, water-holding pockets. Such pockets were inclined to cook-out every summer. These trenches were made with a chain saw, using an old blade.

After the removal of soil he had a clean trench approximately 10 inches deep and $\frac{1}{4}$ to $\frac{3}{8}$ inch wide. The trench was then filled to the surface with a calcined clay product. Gerry watered the green heavily and drainage took place. It was amazing the effect the small drain trenches had on surface-draining this green. After two years, the originally installed trench continues to be effective, even though the green has been aerated, the cores chopped and top-dressing applied.

To date, it is impossible to determine exactly how long small trenches will remain open. Even if clogging does occur, the upper inch or so of "dirty" calcined clay could be removed and replaced quite easily. Satisfactory putting turf forms over trenches within one week to ten days.

As a result of the information gathered by talking with Gerry Murphy, I have suggested to many other golf course superintendents that small, chain saw slit trenches be installed in greens where water-holding pockets are a problem. The success is truly amazing. The picture showing Bill Madigan standing on one of his greens at Forest Lake Country Club in Detroit is a good example of how slit trenches

are to be placed. The area where the flagstick shows, or the area to the right of and slightly behind Bill, is the culprit in this instance.

The water-holding pocket that existed here was so serious that they decided to completely rebuild the green. But as a result of the herringbone slit trench installation, the green has not been rebuilt, and the low, water-holding area is no longer a problem. Even though the trenches in this picture appear to be wider than $\frac{1}{4}$ to $\frac{3}{8}$ inch, this is simply because the job was completed just before the picture was taken and extra calcined clay is lying on the surface.

I have seen numerous types of slit trenching on greens, beginning with simply one slit dug through a low, water-holding area and continuing off the green. With others, a complete herringbone arrangement such as the one in the picture above are installed. Of interest here, off the front of the green in the collar area, the small slit trench actually runs into one of the three-inch wide gravel-filled slit trenches. Bill wanted to be sure the entire area drained rapidly.

It has been observed that slit trenching is an excellent tool for use on a golf course. We have found that it is far easier to maintain turf-grass in top quality condition if surface water is rapidly removed. Even though observation has not allowed any decisions to be formed to-date, slit trenches may also be effective in removing surplus water in winter where dangerous ice sheets are inclined to form.

Effective Turfgrass Weed Control

by A. THOMAS PERKINS, Instructor in Agronomy, Pennsylvania State University

Advancing technology has touched all fields of endeavor. The science of turfgrass management is no exception.

One obvious example is in the area of weed control. The increasing number of herbicides now available to turfgrass managers has resulted in their unconscious addition of one word to the topic of weed control. That one word is "chemical."

In some respects this can be viewed as an unfortunate development, based on the fact that many people use chemicals as a panacea for weed problems. They fail to place herbicides in their proper perspective.

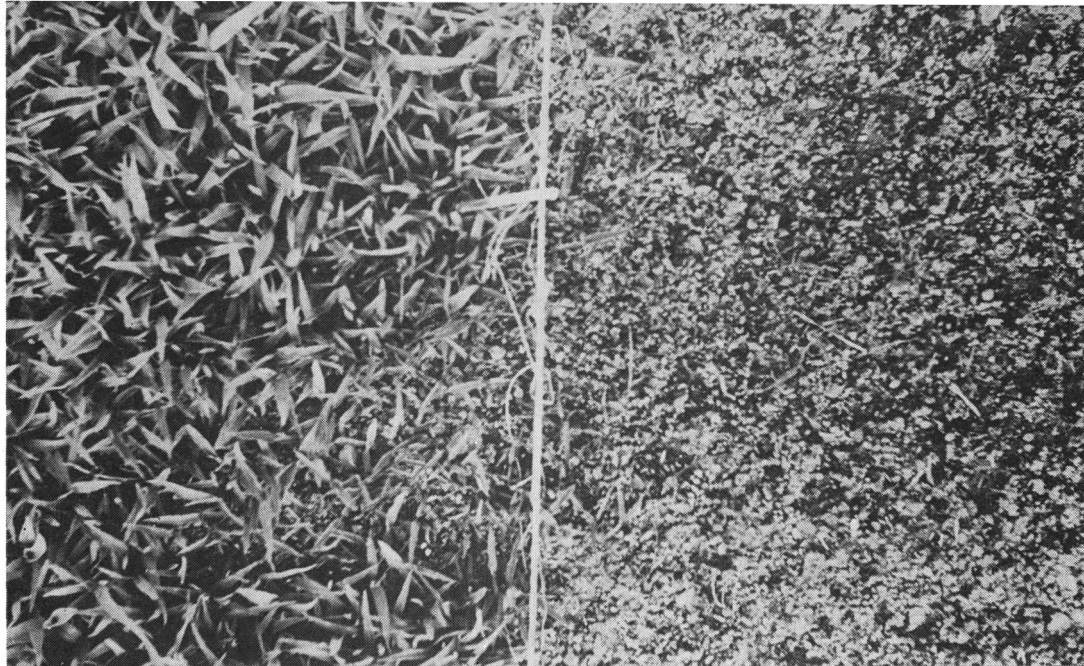
Herbicides are just one of the many useful tools that can be incorporated into an overall management program based on the application of sound agronomic practices designed to pro-

vide the best possible conditions for growing turfgrasses. With these thoughts serving as a guideline, a review of today's weed problems and some of the more useful herbicides is in order.

If documented proof of the importance of weed control problems were needed, the 1966 Pennsylvania Turfgrass Survey has provided more than enough. A review of the weed related sections in that report shows that weeds are the No. 1 turfgrass problem when all turfgrass areas (home lawns, parks, cemeteries, golf courses, etc.) are combined. Weeds rank as the second most troublesome problem on golf courses, the most intensively maintained turfgrass areas. Narrowing the field of possible weed pests down, the survey reports that golf course superinten-

30 lbs. ai/A of bensulide — 6 ft. wide darker green strip across 16 strains of bentgrass — color difference due to absence of Poa.





Closeup of control plot of crabgrass (left) and 9 lbs. siduron ai/A (right) treated and seeded May 27 — picture June 15.

dents ranked their weed problems as follows:

- | | |
|------------------------|-------|
| 1. Poa annua | 24.3% |
| 2. Knotweed | 22.1% |
| 3. Crab grass | 21.0% |
| 4. Broadleaved Weeds | 18.4% |
| 5. Goosegrass | 8.1% |
| 6. Miscellaneous Pests | 6.1% |

This list provides an excellent basis for a discussion of turfgrass herbicides, since the majority of weed control research has been devoted to one or another of these species.

CRABGRASS

This annual pest has received the greatest attention from researchers because of its widespread and continual occurrence.

Crabgrass control has envolved to the predominant use of highly selective pre-emergent chemicals. These chemicals must be of such a nature that when applied to an area they stay in place to afford maximum levels of control over an extended period of crabgrass germination. This same characteristic has also eliminated many promising chemicals from common use, because their excessive immobility in the soil has resulted in residual toxicity to some desirable turfgrass species. Additionally, the trend today is towards dry formulations of these materials. These dry products offer not only ease of application but also a generally higher level of control than their sprayable counterparts.

If crabgrass control were the only criterion for recommending a particular chemical, an almost endless list of materials could be presented. Certainly this isn't the case, and the safety of these chemicals on the various turfgrass species weighs heavily on their final selection. Not all recommended chemicals are safe on all turfgrasses but at least one material is suitable for every situation. An examination of the recommendations of the experiment stations in the Northeast would yield a combined list such as follows:

1. H-9573
2. Benefin
3. Bensulide
4. DCPA
5. Siduron

A more detailed discussion of these materials is necessary to understand their best usage potential.

H-9573 (Azak) should be limited to infrequent use on bluegrass turf. It has shown definite injury to both the fine leaved fescues and to the bentgrasses. In a continued program of crabgrass control, H-9573 has shown residual toxicity even to bluegrass. Crabgrass control in general is good to excellent. (90% or better).

Benefin (Balan) is a relatively new material on the crabgrass market and still requires more examination. Its performance to date, particularly with regards to injury, has been inconsistent. Injury to bentgrass and fescue has

occurred and a few reports of bluegrass injury have appeared. Nonetheless, crabgrass control is good to excellent and final conclusions have yet to be drawn.

Bensulide (Betasan or Presan) finds its primary use on bentgrass turf due to its high level of safety on most of these sensitive species. Control results have been good to excellent.

DCPA (Dacthal) has consistently given the best performance on bluegrass turf over a period of about ten years. It can be injurious to bentgrass and usually does cause injury to red fescue turf. In addition to its excellent control of crabgrass, DCPA is the only herbicide which shows an acceptable consistency in controlling goosegrass. Although goosegrass is not as widespread as crabgrass, it usually requires a more concentrated program to achieve satisfactory control.

Siduron (Tupersan) is a rather elite member of the crabgrass herbicide group. This chemical can be applied at the time of establishment and provide an excellent level of crabgrass control while not affecting the germination of the desirable grass species. It is equally effective

on mature turf stands and is considered safe on most turfgrass species with the exception of several vegetative bentgrasses.

With safety as an overriding criterion and the average user in mind, the Pennsylvania State University now recommends three of the above materials for crabgrass control. They are as follows:

Bensulide

DCPA

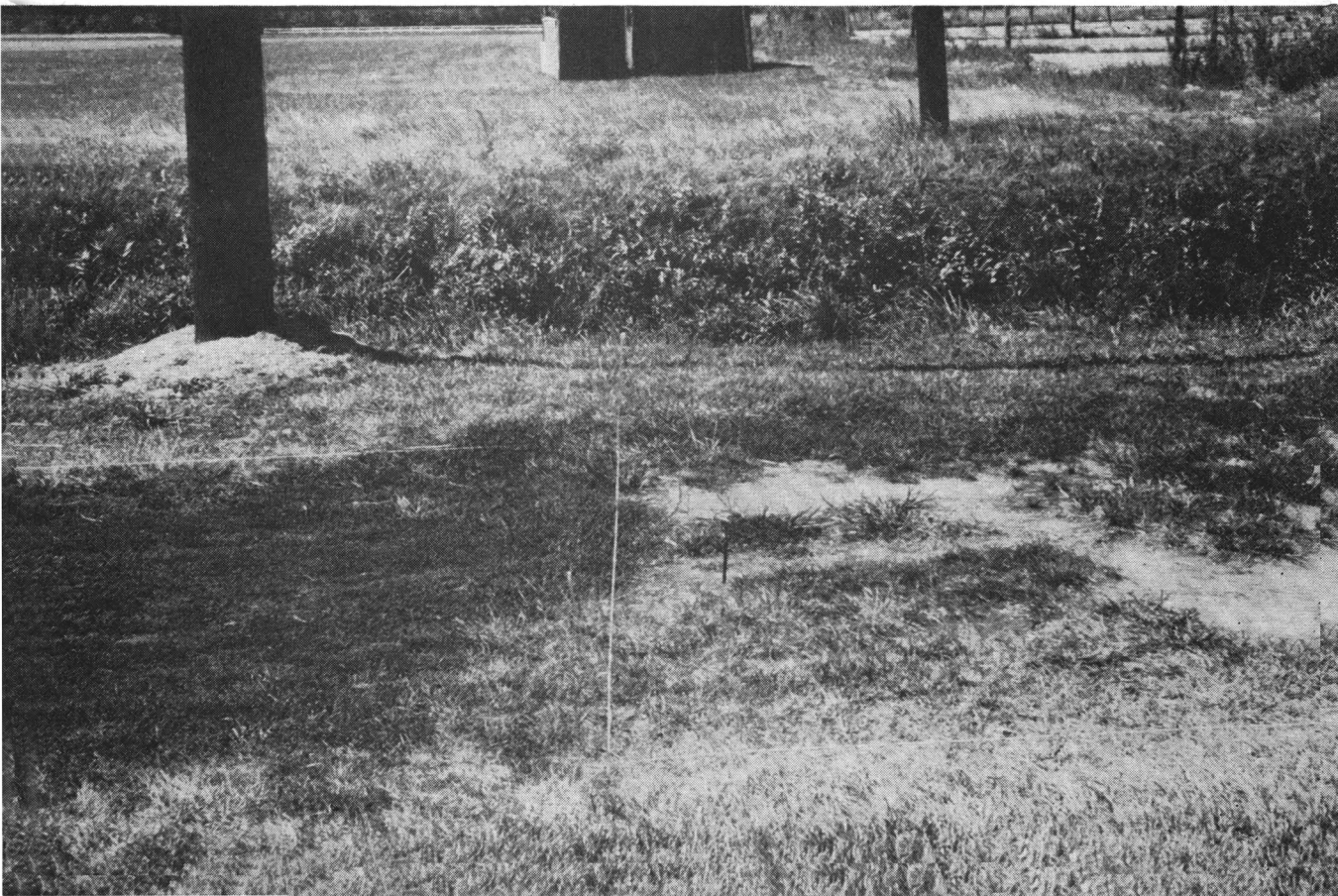
Siduron

ANNUAL BLUEGRASS

Annual bluegrass or *Poa annua* has long been a weed problem on highly maintained, well irrigated areas. Selective control measures have been attempted for years but little success achieved. Chemical control of *Poa annua* involves two areas of major concern, (1) injury to permanent grasses and, (2) residual toxicity as it affects subsequent reseeding operations. Two of the chemicals currently being tested for pre-emergence control of *Poa annua* are calcium arsenate and bensulide.

Calcium arsenate has been somewhat erratic in its performance. Control results have ranged

Knotweed control with dicamba. Near solid stand of knotweed. Plot on left not treated. Plot on right treated pre-emergence spray.



from poor to excellent with unpredictable degrees of bentgrass injury. The ever present phobia of handling arsenicals plus this inconsistency have resulted in increased effort to find other chemicals for this problem. The most promising material is bensulide. Research to date has shown that pre-emergence control levels are good to excellent while no permanent surface injury has appeared. Temporary discoloration during periods of spring moisture stress followed by differential patterns of summer wilting have been observed. These factors would suggest a possible root pruning effect, but more detailed study is needed before positive statements can be made.

Successful reseeding following herbicide application may also cause some difficulty. On areas containing a fairly uniform distribution of *Poa annua* where its density isn't excessive, reseeding shouldn't be necessary. For areas requiring reseeding, success depends on being able to place the seed in contact with the soil below the surface herbicide layer. Greatest success in this respect has been obtained using mechanical grooving equipment.

With difficulties such as these still to be solved, the annual bluegrass problem may be with us for some time to come. Nevertheless, the performance of bensulide to date offers considerable hope that it may soon be recommended for incorporation into an overall *Poa annua* control program.

BROADLEAF WEEDS

This rather large grouping of weeds contains the remainder of our major weed problems. Chemical control within this group involves two stages of turfgrass maturity.

Mature Turf

For many years, broadleaf weed control on mature turf meant 2,4-D or one of its closely related derivatives. The addition of several new herbicides to this market have eliminated many of our most troublesome broadleaf weeds as serious problems.

Dicamba provides a reliable control for mature knotweed, white clover, and many of the weeds which were formerly classified as difficult to kill with 2,4-D. Mecoprop allows treatment of the close cut bents without fear of temporary discoloration or permanent injury. Beyond its safety benefits it offers excellent control of



loxylnil at ½ lb. ai/A sprayed across 4 seeded strips in early post emergence condition. Bare area was seeded to mixture of broadleaf annual weeds, shows complete control. Three grass species were able to develop into acceptable stands. Seeded August 30, treated September 17. Picture October 1.

white clover and chickweed.

With this trio of chemicals to work with, the major emphasis in the past several years has been to develop a combination product which offers a much broadened spectrum of control. This has been achieved by combining 2,4-D and dicamba in ratios of approximately 4:1. The results from such combinations have been excellent and we can now eliminate most, if not all, of our broadleaf weed problems with a single preparation.

One important factor should be understood about 2,4-D-dicamba mixes. When these mixes are being formulated as dry materials, the 2,4-D rate of application must be adjusted accordingly. To be on a level with liquid treatments, dry 2,4-D must be applied at two to three times the rate of the normal liquid application. This factor is essential in determining the effectiveness of dry combinations of 2,4-D and dicamba.

Despite manufacture emphasis on dry materials, it remains a fact that liquid preparations of these same two chemicals offer the most effective control over the widest range of broadleaf weeds. A noteworthy aspect of such combinations is that increasing their wetting properties offers definite control advantages.

Seedling Turf

Short of fumigation, seedbed control of broadleaf weeds has been nonexistent. With 2,4-D as the major herbicide a minimum treatment delay of six weeks was required. Even at this stage the risk of considerable stand reduction was present.

Two experimental materials, bromoxynil and ioxynil, now under test show promise for this troublesome area of weed control. Results at Pennsylvania State University show successful stands of red fescue, bluegrass, and bentgrass can be achieved following early post-emergence treatment with these two materials. As expected, red fescue and bentgrass are more susceptible to injury than bluegrass. A wide range of common seedbed weeds such as pigweed, lambs-quarter, mustard, ragweed, chickweed, and yellow rocket were effectively controlled with both herbicides.

Additional study with these materials is in progress, but results to date would indicate that either or both of these chemicals may alleviate some of our present difficulties with weed

control in seedling turf.

It should be apparent from the preceeding discussion that sufficient management tools, in the form of herbicides, now exist to enable any competent turfgrass manager to control most if not all of his weed problems. The fact that weeds still remain the problem they are today points once again to the view that herbicides are considered by too many people to be cure-alls and not as one management tool in a well-conceived and well-executed management program. Professor H. Burton Musser has expressed this sentiment adequately: "Weed encroachment is the result and not the cause of poor turf."

Generic and trade names of common turfgrass herbicides:

Generic Name	Trade Name
Benefin	Balan
Bensulide	Betasan or Presan
Bromoxynil	Brominal
Calcium arsenate	Various names
DCPA	Dacthal
Dicamba	Banvel-D
H-9573	Azak
Ioxynil	None (Experimental)
Mecoprop	MCPP, Mecopex
Siduron	Tupersan
2, 4-D	Various names

Establishment control of crabgrass with siduron — 22 days after treatment. Six strips of grass seeded the same day siduron was applied. Strip left to right — Merion, Col. Bent, Crabgrass, Kentucky Bluegrass, Red Top, Creeping Red Fescue. Crabgrass completely controlled with all treatment rates 4½ lbs. ai/A — 9 lbs. — 13½ lbs. — 18 lbs. Occasional blocks of crabgrass are control plots.



Enigma of Spring Dead Spot

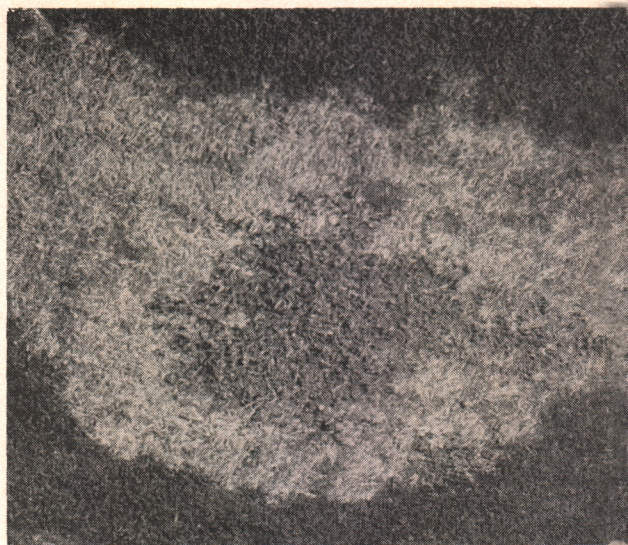
by
JAMES B. MONCRIEF, Agronomist
USGA Green Section
Southeastern Office
Athens, Georgia

Loss of bermudagrass in the northern limits of its adaptation has been of great concern during the last 10 years. Reasons for the exact loss are not yet known but many factors appear to be involved. Spring Dead Spot has definite patterns or outlines whereas winter kill does not.

At the present time studies are being made by two pathologists: Dr. Homer G. Wells, Tifton, Ga. and George M. Kozelnicky, University of Georgia, in Athens. These scientists are trying to establish the cause of the bermuda loss, and at the same time, attempting to control it by various combinations of fungicides, fertilizer, and management practices.

The study of spring dead spot was started in 1957 in Oklahoma by Dr. Harry Young and Dallas Wardsworth. Later, Mallinckrodt Chemical Works released a fungicide (Spring-Bak) showing promise of control in the St. Louis area. However, the symptoms are difficult to pin down since they appear under many different growing conditions.

LOW TEMPERATURES have been associated with this bermudagrass disorder. Bermudagrass suffers the most in the Southeast during winters when the temperature is at zero degrees or just below. This may indicate that temperature is a contributing factor, but not necessarily the main culprit. Many greens go through severe cold periods without loss of bermuda. Therefore, temperature range is possibly the contributing factor involved.

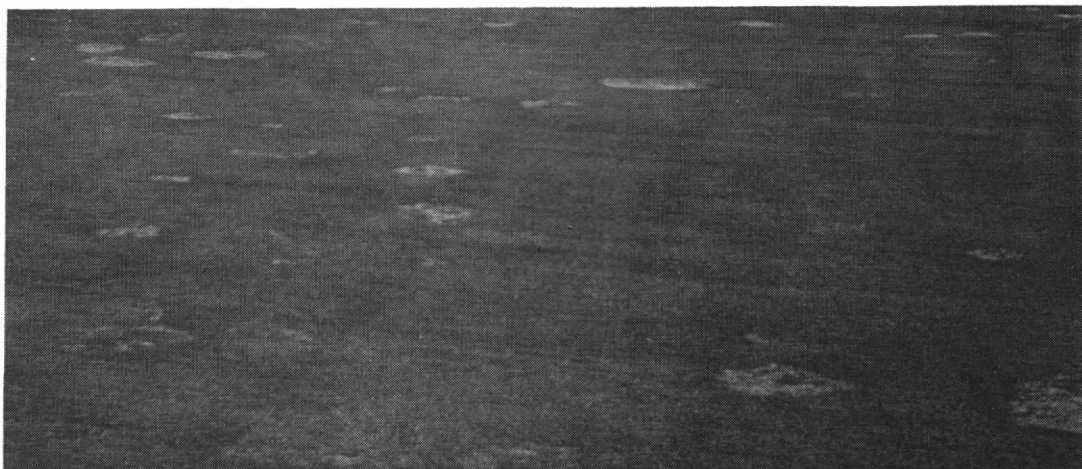


Close-up of typical Spring Dead Spot on bermudagrass

TRAFFIC when bermuda greens are frozen, have frost, or are thawing out from severe freezes, contributes to the loss of bermuda. It would be advisable to close the course under adverse weather conditions, especially those mentioned above. Those in charge of the course should have full authority to make this decision. Furthermore, when hole settings are left too long in one place during adverse weather, bermuda loss is again likely to occur.

THE DISEASE angle has been studied for some time in the midwest, especially Oklahoma and Missouri. Symptoms in the midwest appear to be the same as in the South, yet they have not been proven to be the same. A two-year study shows the major diseases in the southeast to be *Rhizoctonia*, *Helminthosporium*, *Pythium*, *Fusarium*, and *Curvularia*. Perhaps one of these diseases may have been present at one time during the year and thereby weakened the plant and eventually caused its loss. So far, a properly handled nabam-base fungicide has given the best results in the Midwest against loss of the bermudagrass from disease. But this has not been true in the Southeast. Dieldrin has shown promise in this area but, in turn, has been erratic in Oklahoma.

POOR DRAINAGE has caused a terrific loss of bermudagrass by both winter kill and/or spring dead spot. It has been one of the major reasons for rebuilding greens over the last 20



Tifgreen (328) treated with dieldrin in foreground — less spots.

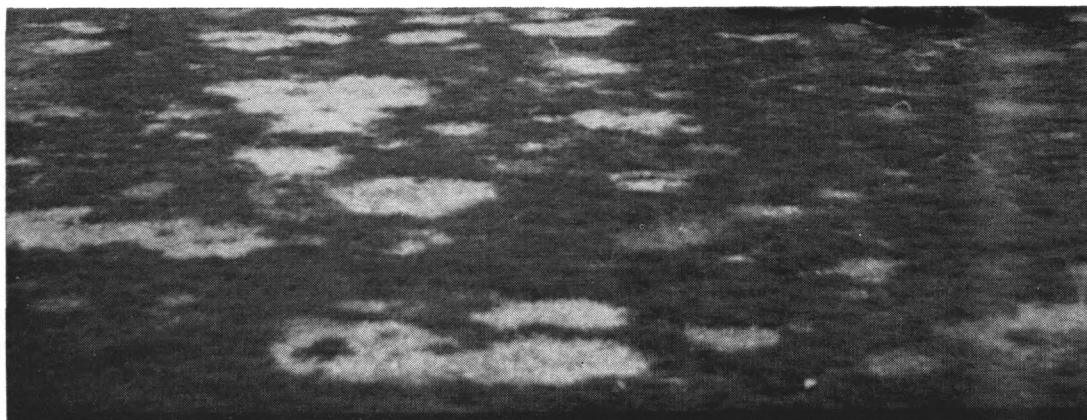
years. New courses are being built today that will have to be rebuilt within five years unless proper construction procedures are followed. Bermudagrass does not do well in poorly drained soils. Low spots and areas where puddles develop are usually the first to experience bermudagrass loss.

SHADE is not good for bermuda greens. They are usually among the first to be in difficulty. Unless a tree is strategically located or is important to the play of the hole, it would be advisable to trim or eliminate it and thus prevent shading of a green.

FERTILIZATION MAY not be the culprit, but we frequently find low pH values and high

nitrogen levels associated with bermudagrass loss. The cause may be due to excessive growth during a disease outbreak, or possibly to a build-up of fungi. This in turn may weaken the grass and regrowth may not occur during the transition period. A slow down in growth brought about by less total fertilization has shown promise.

HEIGHT OF MOWING can influence the loss of grass. In many instances, the "low cut" turf suffers most while "high cut" turf will have no loss. Some courses now mow higher just prior to fall seeding. They also top-dress heavily one week before it. This seems to protect the stolons and helps during spring transition.



The best kept hybrid lawns are first to have Spring Dead Spot.



Drainage can be a factor on greens.

HEAVY VERTICLE MOWING of bermuda greens is not a good practice. Very little vegetation should be taken off the greens, rather, they should be cut lightly at frequent intervals, such as weekly. Do not let them go longer than every two weeks. Heavy verti-cutting weakens the grass, and it takes several days for the putting surface to be acceptable for play. Late fall vertical mowing, such as on the day of overseeding, might very well hinder bermuda-grass survival. If seeding is delayed and the greens are denuded, bermuda is further weakened by cool nights and shorter growing hours. Recovery in the spring is that much more difficult.

DESICCATION may cause a loss of bermuda-grass. With frequent cold fronts moving through the South, a low humidity can exist, and moisture is removed from the upper turf zone readily. The soil becomes dry and the moisture content becomes so low that the grass is weakened. These may cause a poor transition in the spring.

AERATION is one of the best ways to counteract traffic or compaction. Cultivation has been the life saver of many greens. Usually, greens that are thoroughly aerified during the spring

and fall do well. Where there is excess traffic during the summer, it is advisable to aerify the bermuda greens once a month during the active growing period, and cease aerifying about four weeks before overseeding.

To summarize the factors influencing the loss of winter bermuda turf, we could list the following:

- 1) *Dieldrin has shown promise for control of spring dead spot, but is erratic.*
- 2) *Complete renovation of the troubled area has given the best results, but is not always practical on golf courses.*
- 3) *A nabam-base fungicide has given best results in the St. Louis area.*
- 4) *It is best to carry on maintenance practices that encourage strong bermuda-grass growth at all times.*
- 5) *Be sure to go into the winter with very healthy bermudagrass, and minimize disease and other problems that could weaken bermudagrass during the winter.*

There is so much concern and interest in the problem that the second Spring Dead Spot Symposium will be held at the University of Georgia, Athens, Ga., on June 11, 1968.

INTRODUCING LYNN T. KELLOGG:

Superintendent of Oak Hill

More and more college-trained men are now entering the golf course superintendents field, and Lynn T. Kellogg of Oak Hill Country Club, Rochester, N.Y., is a good example of one such highly successful career man. Lynn directs the course maintenance program at the site of this year's U.S. Open Championship. He is a graduate of the New York State College of Agriculture (Morrisville and Cornell) where he majored in Agronomy, but also took many helpful courses in related fields, such as entomology and plant pathology. His college training helped considerably when he became assistant to Elmer J. Michael at Oak Hill Country Club from 1953 to 1961. The Open Championship was held at Oak Hill in 1956, so Lynn will be no stranger to the task facing him this June. Lynn was away from Oak Hill from 1961 through 1966 when he was employed by neighboring Irondequoit Country Club.

He is active in associations, conferences, and meetings that are devoted to golf course turfgrass. He is a past President of the New York State Turfgrass Association, past President of the Finger Lakes Association of Golf Course Superintendents; he is a Vice-President of the



New York State Federation of Golf Course Superintendents, a member of the Finger Lakes Association of Golf Course Superintendents, and a Class A member of the Golf Course Superintendents Association of America.

TURF TIP

How much would a quart of white enamel paint and an extra set of cup liners cost your club? Not much when seen from the golfer's viewpoint. Every member who plays golf reaches into the cup on every hole of the course to retrieve his ball.

How much more enjoyable, how better groomed the course, how much better the target for putting if each hole has a clean, white cup liner. And it's easy to do by replacing them every few weeks with freshly painted ones from an alternate set.



LEATHERJACKETS:

New Pest for Golf Greens

by DR. A. T. WILKINSON, Entomologist, Canada Department of Agriculture,
British Columbia

One of the most common and damaging turf pests of northwestern Europe could become a serious pest in the well-cared-for turf of golf courses, especially in cool, coastal areas. During the past three years the leatherjackets, or larvae of the European marsh crane fly, *Tipula paludosa* Mg., caused severe damage in lawns, boulevards, pastures, and golf courses near Vancouver, British Columbia.

Occurring in Nova Scotia since 1955, its known distribution in the Pacific Northwest is from Vancouver to about 65 miles east and 25 miles south near Blaine, Washington.

The European marsh crane fly has one generation a year. The adult crane flies emerge from the soil at night during August and September, peaking about September 1. They are harmless themselves; only the larvae are damaging. Adults are light brown to reddish brown with the body about 1 inch long. The

narrow wings have a span of about 1½ inches and the legs are about 2 inches long and very delicate.

They mate within a few hours after emerging and begin laying eggs immediately on or near the surface. Each female is capable of laying about 280 eggs. The eggs are black, shiny and very small. They hatch in 11 to 15 days. Fortunately the eggs and newly-hatched larvae have very high moisture requirements; without moisture in these stages, mortality is very high.

The larvae have no legs and are greenish grey. The new larvae start feeding the first day and will continue to feed through the winter during mild periods. Feeding and damage is heaviest during March, April and early May by which time the larvae are 1½ inches long.

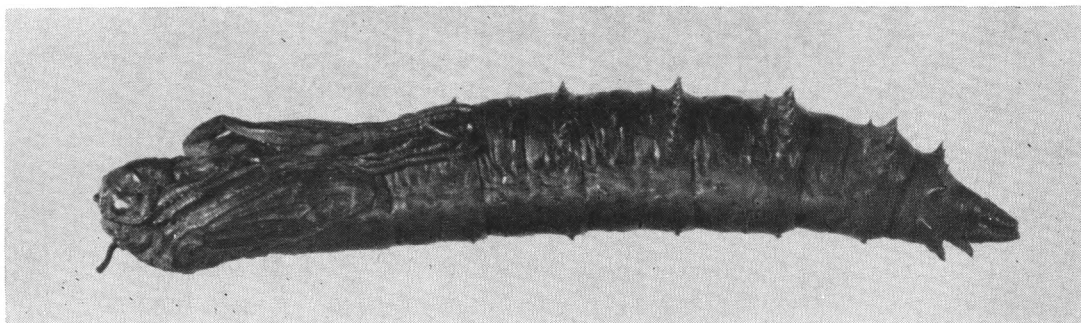
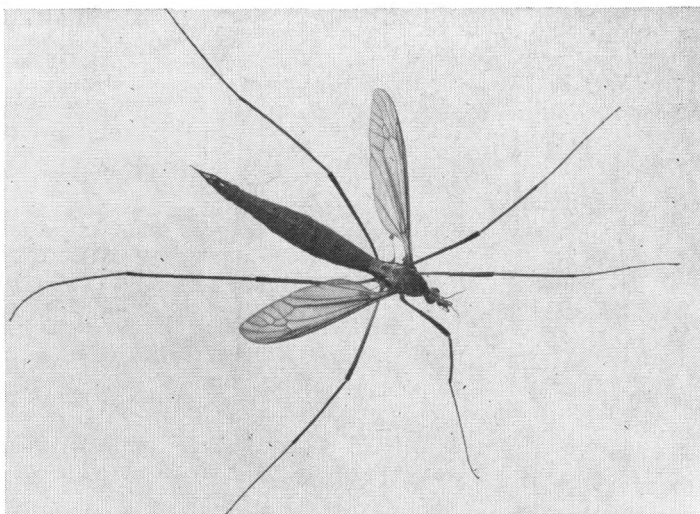
The leatherjackets feed on all parts of the plant and on dark, warm days and warm evenings they can be seen feeding on the blades and

FIGURE 1 — Mature 3rd-instar larvae of *T. paludosa*.



Right: FIGURE 2 — Pupa of *paludosa*.

Below: FIGURE 3 — Marsh crane flies, *Tipula paludosa* in copula.



crowns of the grass. In heavy infestations the valuable grass appears not to be growing, although weeds and coarser grasses continue to grow. In heavy infestations bare patches appear.

The larvae stop feeding about mid-May and move down in the soil to a depth of about 3 inches where they remain until they pupate in late July and August, then emerge as adults to complete the life cycle. The empty pupal cases may be seen at this time protruding one-half inch from the soil surface.

Because the pest has only one generation per year it can quite easily be controlled with one treatment either in fall or early spring. Currently DDT or aldrin at about 3 pounds of toxicant per acre are recommended and these have given excellent control on lawns, golf greens and boulevards around Vancouver. At the present time there is no approved control for this pest on pastures or forage crops that are to be fed to livestock.

Suspected infestations can be confirmed by pouring about one-half cup of gasoline on six square inches of sod. Gasoline irritates the

leatherjackets and they come to the surface where they can be counted. Gasoline also kills the grass, so it should be used sparingly, and where damage will not show.

In Europe, workers consider that 10 per square foot would cause serious injury to grass, and 20 per square foot to be a heavy infestation. Lawns and pastures in the Vancouver area have had more than 100 leatherjackets per square foot. There appears to be little natural control in the way of parasites, predators or disease, but dry weather effectively reduces the population, especially during the egg laying and hatching periods.

If leatherjackets are found outside the known areas of infestation they should be identified by an entomologist. We have many native species that are fairly similar in appearance, but they do not build up like the European species and they cause no damage. Do not use insecticides unless necessary and treatments should be made in late fall or early spring when the least damage will be done to bird and animal life.

TURF TWISTERS

A BUMPY PUTT

Question: Why is it that our greens are bumpier in the spring, especially during cold, wet springs? (Mass.)

Answer: Most greens contain a mixture of *Poa annua* and bentgrass. During cold weather the *Poa* grows luxuriantly but the bentgrass does not: it lies semi-dormant until the soil warms, hence this unevenness. The bumpiness is further caused by the stemmy and bristly growth of *Poa annua* seedheads which flourish abundantly in spring.

AND SPOTTY TIFGREEN

Question: Our club used a pre-emergence herbicide on our Tifgreen greens in early March. After growth began, we found some small bare spots in greens. The bermuda covered over these spots, but in June we vertically mowed the greens and they thinned out severely. What treatment do you advise? (Oklahoma)

Answer: These greens were examined and it was found that the bermuda growing over the bare spots failed to penetrate the soil with new roots. We recommend aerifying, heavy top-dressing and heavier watering than usual. These treatments are not guaranteed to alleviate your troubles completely. You may have to wait until the herbicide has dissipated before normal growth may be expected. In the meantime, do not vertically mow or brush the greens. Depend upon repeated top-dressing to control grain and stemminess.

A GLUEY TANK

Question: Under "Color Me Green?" Turftwister last November, you suggested adding an ounce of magnesium sulfate per 1000 square feet when spraying fungicides, herbicides or fertilizers to greens. Our 25 years of experience indicates that this causes a precipitate to form in the presence of certain fertilizers. A solid or gluey-like substance collects in the bottom of the tank. Now what do you say? (Ohio)

Answer: Would you believe we're both right? The same phenomenon (i.e., precipitation in the spray tank) occurs in other sections of the country as well. In California, for example, the cause has been traced to the presence of certain soluble salts in the domestic water supply. But it does not occur everywhere; only in those areas or under those conditions where the particular salts causing precipitation are present. Therefore, most superintendents could use the idea.