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Summer 1966

TURF BULLETIN

MASSACHUSETTS TURF AND LAWN GRASS COUNCIL
INCORPORATED

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BETTER TURF THROUGH RESEARCH AND EDUCATION

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TURF BULLETIN

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The Massachusetts Turf and Lawn Grass Council Incorporated is chartered under the laws of the Commonwealth of Massachusetts as a non-profit corporation. The turf council seeks to foster "Better turf through reseach and education".

More detailed information on the subjects discussed here can be found in bulletins and circulars or may be had through correspondence with the editor.

Massachusetts Pesticide News

by DR. E. H. WHEELER
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Danger in Trademarks and Trade Names

Purchasers of pesticides must be educated to **look beyond the trademark or trade name on labels.**

People ask for "Scope"; there are 4 "Scope" products on shelves, one contains Di-Syston, one Meta-Systox, one Dyrene, the other a mixture.

There are 5 or 6 "Raid" products, each containing different ingredients and for different uses.

Names like Scope, Ortho, Raid, Heritage House and many others identify a company and its products. They do **not** identify ingredients and uses.

Awell- meaning professor once recommended Black Leaf 253 because, to him, "Black Leaf" meant nicotine sulfate. He did not know that "253" contained parathion.

A well-meaning county agent suggested a person get some "Scope".

During a 3-year period the O. M. Scott & Sons Co. product "Halts" has had 3 distinctly different active ingredient compositions.

This use of the same trade mark or name for products having quite different active ingredients certainly does not add to the effectiveness of Poison Control Centers! **"Scope" is also the trade name for a mouthwash!**

Don't Forget!

"People and Pests", a 16 mm. 14½ min. sound color film is available from the Univ. of Mass. Audio-Visual Center. The public affairs aspects of pesticide usage are well displayed and useful in promoting a better understanding by the general public of the continuing need for pest control.

Federal Agency Transferred

All functions carried on under the Federal Water Pollution Control Act were transferred as of May 9, 1966, from HEW and its Public Health Service to the Department of the Interior and its new Federal Water Pollution Control Administration. Additions and amendments to present regulations under the Act will be issued under Title 18 — Conservation of Power and Water Resources, Chapter V, FWPCA, Dept. of the Interior.

Update Your Publications!

Please review your own reference file and supplies of publications for distribution. **Keep them current,** especially those that include suggestions for pesticide applications to foods, feeds and animals. Publications no more than 1 year old may carry suggestions which could result in illegal uses and/or residues under restrictions.

Pest Control Charts and Guides normally are revised each year — **get rid of all older editions!**

Syrup of Ipecac

Homes with small children should be encouraged to have Syrup of Ipecac available **in case a physician or Poison Control Center recommends it to induce vomiting.**

A note in PN-1-66, January, told of this material being available without prescription. A recent Bulletin from National Clearing House for Poison Control Centers carried an abstract of a study report on the use of syrup of ipecac by PCC's. Highlights: (1) material is being widely used by Centers to induce vomiting, (2) it is highly effective, (3) data

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Tall thick grass grows profusely, with the aid of flyash, in field behind 200-Mw power station

Evangel Bredakis and Henry Page *

Can flyash support plant life?

Research in agronomy, spurred by desire to find use for combustion by-product, shows promise for grass in initial trials

Flyash, accumulating at the rate of 200 to 300 tons daily has spurred the Western Massachusetts Electric Co to seek assistance from the University of Massachusetts to research a constructive use for this plentiful combustion by-product.

Officials of Western Mass were aware that this flyash, the residue from burning about 2,000 tons of coal daily, would create a storage as well as an aesthetic problem. As the flyash leaves the boilers it is mixed with water and piped out to a large settling bed area to the rear of the plant. These slurry beds are diked, using dried flyash left over from past operations. As operations at the plant increased, additional tons of flyash were deposited adding to the difficulties.

Agronomists at the university were consulted, and agreed to perform a series of experiments to determine whether or not flyash could be used economically for agricultural and conservation purposes.

During the first two-year period, starting in 1963, the plant and soil scientists of the university carried out a series of experiments which had the following objectives in mind:

☐ To establish suitable vegetative cover for flyash disposal areas, to control dust blowing as well as to beautify such areas;

☐ To find, if possible, a suitable and practical use for flyash.

Although the Northeast region was involved in a prolonged drought period, experimental plots at the plant showed remarkable results. Kentucky 31, Reed Canary, Creeping Red Fescue, Barley, and Annual Ryegrass all showed from good to excellent germination and growth. Armed with this evidence, the university and the utility planted approximately six acres with Kentucky 31 or Tall Fescue. Because of the drought conditions, it was necessary to install an extensive system of irrigation pipes which drew water from the

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adjacent Connecticut River to stimulate germination and growth in the seeds and tender shoots.

With a regular but inexpensive fertilizing program established, the grass has matured into a thick turf that thrived through the arid New England summer of 1965 without any further artificial irrigation. In the meantime, agronomists at the university were checking the chemical content of flyash and found it was a rather basic medium and contained fairly large percentages of magnesium, calcium, phosphorus, iron, aluminum, plus various amounts of trace mineral elements; nitrogen and potassium were either low or absent.

Commercial fertilizer supplies missing minerals

The lack of nitrogen and potassium in the flyash on the plots was offset by an application of a 10-10-10 commercial fertilizer along with a supplemental feeding of nitrogen. These additives were found significant in turf plots used in the investigation. Results suggest that under normal usage, with regular applications of a commercial fertilizer, perennial grasses would grow and maintain vigor.

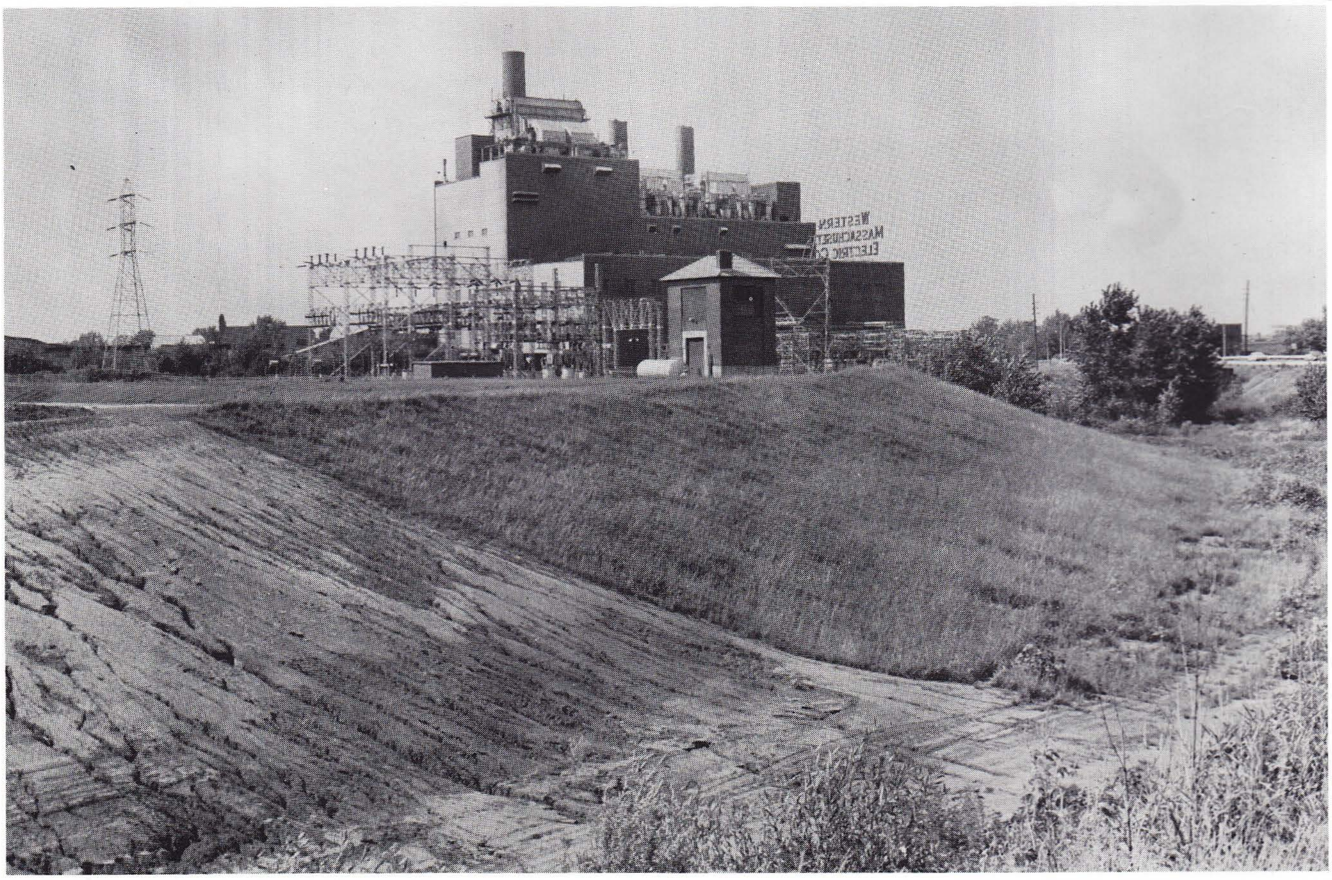
Further investigatory research is now underway to judge the relative merits of flyash planted to trees and shrubs. Some of the results are promising but trees and shrubs require a much longer period of observation before a decisive conclusion can be reached.

Flyash, a by-product of Western Massachusetts Electric's generation, also offers some possibly interesting additional marketing outlets. One of these, which is the second major area of research is the relative value of flyash as a soil amendment, or as a deterrent to eroding roadside embankments and other man-made or natural slopes where thin soil or sparse vegetation is easily washed away during rains or other natural phenomena.

Samples of the coal flyash were examined by University of Massachusetts agronomists and they found that it could very well be classified texturally as a very fine sandy loam. However, unlike fine sandy loam, the hydraulic conductivity of flyash was somewhat lower; thus, affording more moisture retention and a retardant to quick run-offs.

In line with President Johnson's recently announced highway beautification program, it appears that flyash from Western Mass Electric's plant may be able to offer a practical solution to highway slopes which are stabilized with difficulty. Only 5% of flyash mixed with on site soils has provided a marked decrease in washouts, while at the same time adding typically deficient nutrients with the exception of nitrogen and potassium to the soil base. Further trials are being conducted in this area and additional results will be reported on from time to time.

It seems, then, that research-minded Western Mass Electric, by supporting this project, may be able to make a major contribution to agricultural and conservation technology with its by-product, flyash. The time may soon come when flyash, once thought a drag on the market, will be sought after and find its place back helping Mother Nature whence it came.



Before and after planting the flyash dikes with Kentucky 31 grass seed; an ash slurry setting lagoon in the background

The New Golf Course And The Superintendent

by JOSEPH S. FINGER

Golf Course Architect

Houston, Texas

It seems that the time has come for all good country clubs to come to the aid of their superintendents, and vice-versa. As a matter of fact, the time has come to find out whether a club really has a superintendent, or whether it has someone who has been on the payroll mowing grass, raking traps, and either ignoring or creating problems.

A poor golf course superintendent can ruin the best work of the best golf course architect in two years' time. A good superintendent can cure many of the mistakes of a poor golf course architect in five to ten years' time.

And a good club will recognize the merits of a good superintendent, and pay a good salary to get one.

Few clubs can, or want to, pay an architect to stay on with the supervision of the growing and grooming of the turf until the day the course opens. And even fewer will spend the money to keep an architect on a nominal consulting fee for an extra year, to be sure that the manicuring and maintenance carries out the architect's original concepts. It has been customary for the architect's responsibilities to cease, and the superintendent's to start, when the course is planted. At this point, the course will be started on a path of success or failure, depending on the superintendent.

If the course has been designed and constructed properly, the superintendent can bring it into full bloom. Or, he can start using practices born out of hearsay, outdated rules-of-thumb, copy practices of nearby courses which have entirely different qualities and problems, and he can ruin the course gradually but surely.

The strange (to the uninformed) part about this is, it isn't apparent for two or more years. The action might be called "termitic." When courses, greens in particular, are new and uncompacted, anyone can grow grass. We have often quipped, "We can grow grass on concrete if you'll just aerify it a little!" But poor maintenance practices, particularly with regard to top-dressing the greens, can slowly but surely destroy the best construction known in the business today.

Many articles have been written about the role of the superintendent in the maintenance of a golf course. Quite a few articles have been written on the relationship of the superintendent to the Green Committee, or to other club functions, etc. Very few articles have been written on the role of the superintendent in developing a new course. And most articles in any category pre-suppose that a superintendent knows what he is doing and is adequately trained for the job. Unfortunately, such is not always the case.

The construction of a new course or the reconstruction of an old course might be compared with major surgery on a human being. It seems foolish to employ a great surgeon for a specific job and turn the patient over to a staff of unqualified nurses for recovery. Obviously, the patient might die or become very ill again if the nurses are incompetent. It does not take many doses of the wrong medicine to create a relapse or something worse.

The same analogy holds true with golf courses. An architect who really knows his business and who has carefully *engineered* the golf course (and I don't mean merely "laid out" 18 tees, greens and fairways), probably selected special mixtures of existing top soils, with special sands and special additives, to create a seed-bed which will be suitable for growing grass at a height which nature never intended. The conditions of heavy traffic, intense sunlight or intense cold, sometimes all too inadequate air ventilation, and other factors will contribute to the early death of the grass, except under the skilled hands of the "nursemaid" superintendent. The architect, if he has paid the proper attention to the soils, might have also modified existing fairway top soils for porosity and capillarity, pH, organic matter, or other properties necessary for a healthy fairway turf. Undoubtedly, the architect who has paid great attention to detail and to the final sculpture of the land has also created subtle undulations or warping of the terrain, to give the necessary "sight values" and "shot values" for a really challenging golf course.

Yet, an unqualified superintendent can take over this golf course, start using the worn-out "rules of thumb," and create a disastrous situation in a short period of time. He can undo everything which the science and technology of the various universities and the U.S.G.A. Green Section have developed over the last fifteen or twenty years, and throw the greens back in the same "dark ages" which existed some forty years ago.

For an example, modern technology usually requires that the final seed-bed of a green end up with a sand content of 70% to 80%, or more. Furthermore, the type of sand must be selected and blended with existing top soil and organic materials in such a manner that the capillarity and porosity will be approximately balanced. Often this calls for using a relatively porous sand, with a particle size of 0.2 millimeters to 0.8 millimeters, as the major portion.

Yet the superintendent, particularly one who has not been subject to the recent advances in agronomy, might feel that the seed-bed mixture is too sandy, or "weak." So, as soon as the golf course architect has turned over the course to the club, the superintendent sets out to "strengthen" the mixture by applying a top dressing of a "1-1-1" mix, or "2-1-1" mix, or some other rule-of-thumb mix, which he has been accustomed to on the old course. In a period of two years, if someone isn't carefully checking on this, he might build up as much as a quarter of an inch or more of a top

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the idea, and he feels that it is easier for his men to work in one area or on one or two fairways at one time. So he puts as many sprinkler heads as he can get by with on two adjacent fairways; and, after these two fairways have been watered, he moves to two other fairways.

The end result of this move is that the individual sprinkler heads have too little pressure because of the friction losses in the lines, and they do not reach their maximum effective diameter. The drop size becomes too large, creating erosion problems, and the outer edges of the fairways or the roughs do not receive water. Velocities exceed safe limits, and pipes rupture from water hammer. I have seen as many as nine giant sprinkler heads, designed for 80 gallons per minute each, on one fairway, where the watering system plan called for two!

Now this is great for the water man, since he's out to show the boss that he really watered the course. The more water that stands, the more he's sure the boss will see it and note that the course is well-watered. He has no idea of how fast that fairway will accept water, nor does he care how much water is wasted.

The superintendent who is not on his toes with the new course might also make another fatal mistake in watering his greens. With the type of greens to which he might have been accustomed, in which the ratio of clay and silt was high compared with the sand content, it often took thirty minutes or longer to bring the seed-bed to its proper moisture capacity. It was usually thought necessary to have water standing on the greens before one could really be sure that sufficient water had been applied. It is virtually impossible to make water stand on today's well-designed greens which use high porosity mixes. Unless the man who actually does the watering understands this, he will leave the water on for two, three or four times the length of time required to get water to the roots, in an effort to make sure that the superintendent sees water standing on the green. If the green has adequate sub-drainage, the only thing the watering man is doing is to leach out the fertility of the green and wash it down the drains. The greens then become "weak" looking, and the superintendent fertilizes, and the greens recover. The process is repeated, and the greens get weak again. We then have a "sine curve," when the condition of the green is plotted against the calendar. After each fertilizing, the condition goes up; and, soon thereafter, the condition of the green drops. The superintendent should have available at his command a relatively simple test of determining the length of time required to bring the moisture content up to a certain level, and he should set the number of minutes, within reason, that the watering system man should keep the sprinklers on, regardless of whether water stands on the surface or not. This is a difficult change-over for most superintendents. It is one of the strongest arguments in favor of the automatic greens watering system.

So, when the fairways begin looking weak, after the fertilizer has been leached out and has run downhill into some stream, the members or the Green Committee complain to the superintendent, who will state that the trouble is he can't get enough water on the fairways. His reason is that the water system is poorly designed, and it should have been looped all over the place so that he could get adequate water from two sources instead of one. (Of course, if the watering system has been designed properly, looping is generally not required.) Furthermore, even if the system is looped, the use of the maximum number of sprinkler heads on both legs of the loop will *not* give more water or pressure on either leg. So we get back again to the problem that the superintendent does not understand the hydraulics of the watering system. Often he is not willing to study the design of the watering system and be sure that his personnel understand the operating capacity and limits.

In the above discussion, we have been putting the superintendent on the defensive, as if there were no superintendents capable of taking over the job of developing the course. This is certainly not the case. As hinted in the opening paragraphs, there are many superintendents who can, and must, spend years correcting the mistakes of unqualified designers or builders.

We have seen that the superintendent must understand thoroughly the problems of porosity and capillarity of the greens if he is to get air and water down to the roots. We have also seen that he must understand the hydraulics of the watering system, so that he knows what combinations will cause too much pressure drop through the line, what will cause waterhammer and possibly create broken lines, and just how much time each green must be watered so that it will not lose its fertility. He must also understand his chemistry of fertilizers, insecticides, herbicides and additives, to permit effective control of natural enemies of the grass on his greens, fairways and tees. Since the maintenance of an 18-hole course might take anywhere from six to twelve men, or more, depending on the quality of course desired, the superintendent must also be able to organize the efforts of his workers, be a purchasing agent, be a mechanic to keep the equipment in good operation, be a gardener for the rest of the club property, and be a diplomat with each member of the Green Committee who comes to examine his books, complain about the condition of the course, or schedule a tournament just when fertilizing or verti-cutting was planned, etc.

Now, Mr. Chairman of the Green Committee, or Mr. Owner of a Golf Course, take note: You are not going to get this in a "good old farm boy," who knows how to grow grass because "he lived on a farm." What you need and what you are asking for is a man who, either because of training or experience, has become an agronomist, a good businessman, a good mechanic, a purchasing agent, and a manager. At least, if the superintendent is doing the job he should, he will qualify in each and all of these categories. It takes a decent salary to get and keep a man of these qualifications. On today's market, this salary might vary from $500 per month to over $1,200 per month, or more, plus fringe benefits, depending upon the location, the size of the club, the living conditions in the area, etc. If you want your golf course to look like a fine course, then get yourself that good old farm boy who has had plenty of "good old agronomy training" and other training in bookkeeping, mechanical maintenance, handling of men, watering systems, etc. This is usually best found

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dressing in which the particle size has decreased appreciably, the silt and clay content has increased far beyond the maximum for good air and water drainage, and compaction has set in.

How does this show up to the average golfer or to the Green Committee? The first thing that usually happens is the greens won't hold a shot. They become crusty on top, and require excess water to make a shot hold. The same crustiness which causes the ball to bounce when the green is relatively dry will also create a problem where water or air will not penetrate to the roots rapidly. With a high moisture on the surface and a weekened root condition, disease sets in and the grass starts giving trouble. Often weeds will intrude, and the situation will go from bad to worse.

Upon questioning, the superintendent will usually reply, "I told you that weak' mixture wouldn't grow grass." Or, the blame will be placed on a very cool spring, a very hot summer, bad batches of fertilizers, fungus attacks which exist at a club across the city, or labor problems. The truth of the matter is that the superintendent wasn't qualified for the job because he hasn't kept up with modern turf practices and didn't really understand what was required of his services in connection with a first-class golf course.

I think that one of the most important things that the owners of a new club or a new course should do is to sit down with its architect and its superintendent, and pass a law that no one shall alter the top dressing from the same composition as the original seed-bed without consultation with either the U.S.G.A. Green Section or the architect who built the course, or both. If it is found that the original seed-bed had too high a clay and silt contents, or if the particle size of the sand was too fine, then, if anything, a modification of the top dressing might be made toward a larger particle size and a higher percentage of sand, but certainly not the other way. The tendency toward "lensing" or "stratification" should be avoided at all costs.

Another angle which must be considered by the owners of any new golf course is that of the "maturation" of the golf course. Quite often the development of the course, after the architect has left, is the function of the superintendent. He takes over after the course has been carefully sculptured, and he is expected to keep it this way. Yet Mother Nature often deems otherwise, and sends torrential rains to wash out certain areas. Man also makes occasional mistakes and creates washouts of green slopes or putting surfaces with broken water mains or improperly operating sprinkler heads. All too often, I visit courses where these washouts have never been repaired by the superintendent. Often you hear the remark, "That's the way the architect left it," as if that excused the situation.

Still another problem with a new golf course is the fact that, in many cases, the budget available limits the watering system to the point where complete coverage by a center line system is impossible under all wind conditions. The design might allow only for the prevailing wind condition during the watering season; but usually after a course has been in play, it is discovered that a certain area needs watering, and a spur line is run to the area. If the pipeline trenches are not backfilled and tamped carefully, an unsightly and dangerous trench is created, to catch ankles as well as golf balls. You can pretty well judge a superintendent by the number of these trenches on his course.

Then there is the matter of "sodding," or "strip sodding"—that great practice used to stop erosion. It *is* great when properly executed. But how often we see a raised ridge or a bare edge of exposed sod around a green, months or years after the course is in play! The apron mower "scalps" it at each mowing, and golfers turn ankles or stub clubs on each round. Around a beautiful green, it is equivalent to placing a horsecollar around the "Madonna."

There seems to be an almost universal problem of keeping the greens to the original shape and size. There is a tendency on the part of many superintendents to let the greens "grow in'" just a little bit, so that the mowing can be done faster and the budget can be kept down. This not only destroys the original concept of the architect, but it tends to concentrate the wear and tear into a smalller area of the green. It also means a larger apron between the trap and the putting surface, and this encourages buggies to pass between the trap and the putting surface, regardless of rules, regulations and pleadings on the part of the Green Committee. As one famous pro once put it, "I order my men to make the greens three feet larger each day, so they will stay the same size." The Green Committee itself should be very careful before falling prey to the fallacy of making the greens smaller to cut down on maintenance costs. A consultation between the Green Committee, the superintendent, and the architect should be held before any size or shape changes of the greens are made.

A superintendent who doesn't understand his job thoroughly can also ruin beautiful traps. Some superintendents simply do not like to rake sand up the sides of the traps, as they feel it is too much work. Yet if this trap has been designed with a steep bank, the superintendent will merely let the grass grow down the bank until it reaches the flatter area. All the superintendents has done is to substitute an area which has to be mowed by hand, often with a rope on the end to haul the mower back up, for an area where the sand can be raked. Pulling a rake up the hill is a lot easier than pulling a mower up the hill. The end result is that the slope is neither raked nor mowed, but erodes or grows up in weeds.

Another common fallacy on the part of a superintendent on a new course involves the watering system. Usually, today's watering systems cost from 25% to 35% of the entire cost of the golf course. Pipe is not an inexpensive item. Therefore, pipe sizes must be kept to the minimum consistent with pressure drops and velocities if economies are to be effected. This usually means that a limited number of sprinkler heads can be placed on any line at any time. For example, in my design, I usually try to simplify the design for the watering system personnel so that they use one large sprinkler head on the par 3's, two on the par 4's, and three on the par 5's. Furthermore, I usually specify that not more than so many sprinkler heads of a certain size can be used with any one pump at any one time. Somehow, in the shuffle, the superintendent either forgets or doesn't like

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Environmental Control Of Disease -- A New Approach

by DR. H. B. GUNNER
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In spite of all the prophylactic programs which the agricultural industry and its pioneer researchers have developed, fungi and a whole host of pathogens are still with us, and will continue to make periodic appearances for a long time to come. The question often asked, "Is there some other approach apart from a chemical agency which attempts to impose sterility on an environment; a treatment which often falls short of its goal?" Or put another way: "Isn't there some long lasting *natural* method of controlling pathological organisms that incite economic diseases of plants?"

More than fifteen years ago an excellent summary was published on the recognition, with the then available means, of controlling a *Fusarium* fungus, the cause of wilts in carnations. At that time, once infection was recognized, nothing could be done except get rid of the infested plants, soil and fumigate the environment in which the disease had run rampant. Today, a glance at the latest carnation manuals, one finds that for bacterial and fungal wilt of carnations there is still nothing to be done except dispose of the diseased stock, sanitize the soil, or throw it out and then start afresh. Why, then, the failure in almost two decades to find an effective means for treating what is actually one of the major blights, especially of the carnation industry? Perhaps the reason lies in the distance between most growers and the seat of current research.

Many growers' techniques of disease treatment, all too often, represent a "hand-me-down" technology which needs refurbishing in the light of the exciting new approaches taking place in the laboratory. These approaches reflect the new language which the scientists have begun to learn and to develop; the language of environmental science. This is a language which treats each phenomenon in a given situation as intimately related with, influencing, and influenced by, a multiplicity of other events in the same ecosystem. One of the problems which has confronted many soil microbiologists is the relation which the enormous numbers of microorganisms in the soil have to one another. It is known, for example, that the fungus *Fusarium* is invariably present in most field soils. However, only relatively rarely does it cause infection, that is to say, show some dominance over other populations. Therefore, it would appear that there must be natural exclusions operative in the soil by which *Fusarium* is controlled. If these natural exclusion mechanisms could be understood then the soil environment could perhaps be so manipulated as to exclude undesirable, and foster desirable microbial populations.

Among the exclusion mechanisms on which an understanding has emerged in the last decade is that of competition, which is as primary a feature of life among microbes as among men. It is known that different organisms compete for the available supply of nutrient in the soil. The two major nutrients for which competition is most active are carbon and nitrogen. Most groups of bacteria are capable of more rapid use of the available carbon supply than are the fungi. In using carbon, which is actually the skeleton on which these organisms build body tissue and from which energy is derived, accessory needs arise. The carbon insists that nitrogen, iron, sulfur, copper, zinc, and calcium be taken out of the environment so that these rapidly proliferating bacteria grow and deplete a whole series of elements which are necessary for many fungi. The *Fusarium*, for example, in selected instances, is in fact crowded out. It was known thirty years ago that adding organic matter to fields infected with cotton root rot organism was the best, in fact the only means of keeping the cotton root rot down. The organic matter, by permitting the elaboration of huge populations of those organisms most quickly able to utilize its available carbon fraction, created an environment in which the cotton root rot was a losing competitor. This same competition mechanism may have similar possibilities for application with other pathogens.

Another relationship among soil microorganisms of interest is that of predation, the situation in which one organism may attack another by a variety of means. Some bacteria, for instance, are actually able to dissolve the walls of certain fungi — a phenomenon called lysis. It must be borne in mind that one simply cannot dump or plow into a soil a group of organisms which one wishes to prey on another group, since some groups may be excluded by the soil equilibrium. The problem is essentially how can we change the environment so that it itself will foster the organism whose activity we seek to control. When the mechanism of bacterial lysis was examined in detail it was found that a certain bacterium which dissolved the cell walls of *Fusarium* did so because it possessed an enzyme called chitinase. This enzyme, or chemical catalyst, dissolved the chitin portion of the cell wall. It was reasoned that if the organisms which attack chitin could be encouraged to grow in the soil in large numbers, a convenient means would be at hand to also halt the growth of *Fusarium.* The chitin-attacking bacterium, stimulated by an amendment of chitin to the soil, would proceed to fulfill their needs for this compound by also attacking the chitin in the cell walls of the *Fusarium*, and thereby allow its growth pattern to be exploited for man's needs to control *Fusarium.* Such a system has in fact already been experimentally tested. Chitin in the form of lobster shell has been found to suppress the *Fusarium* wilt of beans. Significantly, the addition of chitin did not suppress the growth of this fungi in which chitin is not present.

These are but a few of the relationships in the microenvironment in which only preliminary exploration has been done but which point the way to the new language and method of environmental disease control. This is a language which is finding extension to every phase of agricultural technology. Thus, a whole new science of microclimatology is being developed which is demonstrating the great importance of transmission of minute amounts of gases among plants. From the intimate nature of the living cell, its wall membrane and interior organization, to the interrelationship of organisms among themselves in their physico-chemical environment, all of such information must be better understood and become part of the new technology which alone may successfully eradicate diseases and permit mastery of the environment.

Hints On Playing Field Construction In Great Britain

Difficult maintenance problems on sports turf areas can often be traced back to inefficient construction in the first place. Essential points to watch are as follows:

Plans

It is most important, especially if the work is to be carried out by contract, to prepare accurate plans showing site boundaries, all physical features, i.e., hedges, old buildings, etc., existing and new levels together with the proposed layout.

Specifications and Bills of Quantities

If the work is to be carried out by contract, it is essential to have a precise specification (drawn up by a specialist) describing the work involved, how it is to be accomplished, the materials to be used and the sequence of operation. For jobs over £3,000 it is advisable to prepare a Bill of Quantities in which all the work involved, together with all materials required, is accurately listed for the contractor to price. The preparation of a precise Specification and Bills of Quantities enables competitive tenders to be obtained.

Top Soil

Examination of the top soil should be made (by an expert) prior to preparing a specification or deciding upon future work so as to determine depth, quality and future amelioration. If the depth is less than 4 in. it may be necessary to import top soil. Obviously, for specialized areas such as golf greens, etc., it will be necessary to have a greater depth of top soil.

Grading

If it is necessary to alter considerably the contours of a site to produce the required levels it is vital that all the top soil is carefully stripped and stacked in convenient heaps prior to grading the sub-soil. To avoid future settlement, filling should be laid in consecutive layers not exceeding 9 in. in depth.

After the sub-soil levels have been adjusted to produce a regular gradient the top soil can be carefully returned.

Sub-Soil Cultivation

After major grading works the sub-soil is severely compacted and water penetration impeded. To overcome this, it is necessary to "shatter" the consolidated sub-soil by means of an operation known as sub-soil cultivation. (N.B. This is not mole ploughing.)

The operation should be carried out at intervals of 2 ft. across the site to a minimum depth of 18 in. in a direction parallel to the line of the future main drains of the lateral system. It is important that a powerful tractor (preferably tracked) is used to pull the sub-soil cultivator to ensure smooth continuation of the operation, avoiding wheel spin etc.

Drainage

Practically all sports fields need drains to remove excess water quickly. An expert is required to design the system and he will watch the following points:—

a) The need for a good outlet.

b) The line of the main drain of a herringbone system should be in the direction of the main fall of the land.

c) If the field has been graded to even falls, the mains can be laid at a constant depth — usually 2 ft. or 2 ft. 6 in., i.e., if the slope of the field is 1:60 the fall on the main drain will be 1:60. With the laterals also laid to a constant depth of 2 ft. the fall along their lines will be less as these are laid across the line of maximum fall at an angle (45°) to the main, i. e., approximately 1:85.

On a level site it will be necessary to construct a fall along the drain runs — not less than 1:200.

d) Drain trenches should be excavated cleanly in straight lines.

e) Sub-soil excavated from the drain runs should be removed immediately and not allowed to remain at the side of the trench to contaminate the top soil.

f) Salt glazed or clayware angled junction pipes of the appropriate sizes should be used for connections.

g) Pipes should be laid with closely butted joints and the end pipes of each drain should be sealed.

h) The selection of the backfill material is very important; the material chosen should allow water to pass through it quickly and moreover retain this quality for many years. Material such as coarse clinker, reject gravel, crushed stone, etc. can be used and should be cleanly graded between ¾ in. and 3 in.

Backfill generally should be brought up to within 6 in. of the surface on areas to be cultivated and even to 4 in. from the surface when introducing a drainage system into developed grassed areas.

Further Sub-Soil Cultivation

After the top soil has been re-introduced over the drainage lines it is often found that the sub-soil over the field has again become compacted. This can be overcome by carrying out a second sub-soil cultivation but, in order to avoid displacing the drain pipes, the depth of the operation must be amended.

Cultivation

Rotary cultivators are not recommended for producing the seed bed since, especially on heavy soils, they tend to form a "polished pan" immediately beneath the cultivated soil. Also, rotary cultivation often results in the top soil becoming "fluffy" and difficulty is experienced in producing a firm seed bed. It is preferable to use rigid tine cultivators after ploughing and discing.

Soil Amelioration

The best time to introduce soil ameliorants is during construction. Materials such as coarse sand, peat and dried sewage can easily be worked into the top soil during the cultivations. The type and quantity of both physical and chemical ameliorants required can be determined by an expert after testing samples.

Grass Seed

An expert, after considering soil and climatic conditions, future use of the areas, etc., will advise on the seed mixture required. This should always be purchased from a reputable seedsman who will provide on request a certificate showing composition, purity, germination, year of harvest and country of origin.

The best time for sowing is in the late summer when the germinating grasses are less likely to be competing with weed growth. When sowing it is ad-

(Continued Col. 2, Page 10)

Gingko Biloba

by A. R. Buckley
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The Maidenhair-fern Tree *(Ginkgo biloba)* stands unique in dendrological history as being the sole survivor of one of the most interesting families of trees widely distributed in temperate regions in early geological times. By certain essential characters it is related to the Pine and Yew family of conifers and by other characters such as its flattened leaves and motile male sperms, it is allied to the Cycad and Fern families.

The origin of the tree is surrounded by mystery. No direct evidence has been forthcoming to prove that it is a native of Japan, from where it was introduced into Europe in 1730. It is most commonly seen in China, Manchuria and Korea, where it is planted within the precincts of Buddhist temples and palaces. Specimens over one thousand years old have been reported in these grounds. The tree was first made known to European botanists by Kaempfer, a surgeon in the employ of the Dutch East India Co., who found it growing in 1690 and later published a description with good illustrations of the leaves and fruit.

It appears that his unique relic of a bygone era has carried through the ages many characters that combine to make its continued existence remarkable. It is dioecious, that is, the male flowers are to be found on one tree and the female flowers on a separate tree, and therefore fertilization and the subsequent production of fruit are only possible when both male and female trees are in relatively close proximity to one another. Wind blowing in the right direction at the appropriate time is necessary if the two types of trees are too widely separated. Good evidence of this has been found in the past in the grounds of the Central Experimental Farm, where two female trees exist. One female tree, situated near the Chemistry Building, is close to the male tree and bears fruit consistently each year; the other, planted near the Administration Building, is some distance away from the male tree and has borne fruit only two or three times during the past twenty years. Grafting scions of the female tree onto the male tree was practiced at Kew Gardens in 1911, which resulted in the production of fruit for the first time in England.

Fertilization of the tree differs from that of other trees except Cycads and Tree Ferns as the ovules are fecundated by motile sperm cells conveyed to them by the pollen tubes, but the development of the embryo is not completed until the seeds have fallen to the ground.

The female Maidenhair-fern tree is less desirable for planting than the male tree by reason of the plum-like fruits, which after falling to the ground, become soft and pulpy and emit an extremely rancid odour. Since the sex of the tree is impossible to determine in trees of planting size, the only way to ensure planting male trees would be to propagate them by cuttings from known male specimens. A certain measure of success in propagating this tree has been obtained here by hardwood cuttings taken in December and inserted in sand in a greenhouse with a temperature of 60-65 degrees F.

It is interesting to note that a specimen in the Arboretum planted in 1895 fruited for the first time in 1958. This tree was sent to us from Mons. Le-

PLAYING FIELD (Continued)

visable to divide the total quantity of seed in halves to be sown in transverse directions.

Maintenance

It is essential that adequate maintenance arrangements are made for newly grassed areas. Stone picking, rolling and mowing can be included in the specifications if the work is to be carried out by contractors. Alternatively use direct labour if efficient machinery and skilled operators are available. On general grassed areas, the first mowing should be carried out when the grass is approximately 2 in.-3 in. long. No more than 1 in. of the foliage should be removed and the mowing should be repeated when the grass has again grown to 2½ in. long. The aim for successful mowing should be "little but often."

Newly developed grassed areas are often allowed to deteriorate through bad management in the year following sowing. During this period, which is normally the time when the sward is developing prior to any play, commencing regular maintenance, especially mowing and fertilizer application, is necessary.

A close watch should be kept through this first year and records kept on any "problem areas." If the and records kept on any "problem areas." If the work was carried out by contract, it is likely that these areas can be further investigated and if necessary, rectified by the contractor under a Defects Liability clause.

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GINGKO (Continued)

moine's Belgian Nursery as *Ginkgo Biloba* var. *fastigiata* and is indeed, more fastigiate than the others. However, certain observers have stated that the male tree could be distinguished from the female by its pyramidal or fastigiate habit. This fruiting tree certainly repudiates this conception in this particular case at least.

If one ignores the repulsive scent of its fruit, the Maidenhair-fern tree is quite useful for planting as a street tree or a lawn specimen. Its lovely graceful branches and distinctive leaves provide a splendid contrast to the maples and elms usually seen in these locations.

Cultivation of the tree presents no problems; it grows in all kinds of soil from heavy clay to sandy loam, no insect appears to attack it and neither does it suffer from disease. Only in its very early stages has it suffered from winter injury here. At that time some of the trees planted were killed back a few inches from the tips of the branches.

SUPERINTENDENTS (Continued)

in men who have had college training for the job.

Today, qualified superintendents are scarce. To a large extent, this is a fault of the country clubs themselves. They have not seen fit to keep the salaries high enough to encourage young men to go into this type of work when they enter college. The result is that we often have to use men who are not qualified, and this creates more problems and more expense than the increased salary required to obtain a good man. Often the difference between a qualified man and an unqualified man for the job is only $.50 per member per month. Think of it in this light; then examine your own man and his pay scale. See what your club can do to encourage young men to obtain the necessary training and experience required for a fine golf course these days. If you do not, I assure you that you will have a lot less trouble distinguishing between "acts of God" and "acts of negligence."

Some Physiological Effects Of Soil Salinity

by Roy L. Goss

In order for a plant to maintain turgor or sufficient moisture in its cells, the concentration of salts and other materials that tend to hold water in the cells must exceed that in the water supply to the roots. Excessive salts in the soil solution interfere with the absorption of water by many of our economic plants such as the turfgrasses. Therefore, saline soils, or those with high salt concentrations, are considered "physiologically dry," although the soil is physically wet for these plants.

Plants on saline soils attain most of their growth during the rainy season or when sufficient irrigation water is applied. This causes the soil solution to become diluted, and the salt may move downward below the root zone. When saline soils are used for production purposes, it is wise to select an irrgation system that keeps the soil at the maximum moisture content which is possible without bringing about a water-logged condition. When saline soil has the right moisture content, the osmotic pressure is only about half as high as when plants growing on such soil wilt for lack of water.

In the majority of plants, germination is greatly retarded and seedling survival is almost impossible under saline conditions. Therefore, their successful germination and establishment is usually restricted to those seasons or periods of time when the salts are most dilute.

Measurement of Salinity

The degree of salinity of a soil solution can be determined by utilizing the fact that the greater the concentrations of electrolytes or salts in the soil, the greater its electrical conductivity at a particular moisture content. Soil samples are saturated to obtain comparable moisture conditions, and their conductivity is measured with a Wheatstone Bridge. The conductance of non-saline soils is usually less than 0.5 millimhos per centimeter. Most crops will begin to show injury at about 2 and even the salt-tolerant crops cannot tolerate more than about 8 millimhos per centimeter. Without going into the chemical mechanics and becoming more deeply involved in determinations of salinity, it is well to point out only that these relative values are important in determining whether or not plants will be adapted to certain soil conditions.

Some Common Sources of High Salt Concentrations

The usual source of salts in most soils used by turfgrasses is normally developed saline or alkali soils. These soils have generally been developed under conditions of poor drainage whereby the salts were not leached away in drainage waters. When these soils are used for turfgrass plantings, serious problems can arise unless proper drainage is installed or the salts adequately leached from the soil. Another source of soil salts is that which we apply as fertilizer elements.

Many of our common fertilizers, such as potassium chloride and certain sources of nitrogen, can present toxic conditions if their concentration becomes high enough. One recent soil test indicated 12 millimhos per centimeter, which is considerably above the maximum allowable for growth of turfgrasses. No other soils in the vicinity of this particular project contained salt concentrations that high. Soil tests indicated that the potassium level was in excess of 1000 pounds per acre. Ordinarily, the soils in the particular area from which this test was taken are never that high. It is deduced, therefore, that excessive potassium chloride was applied to the soil and raised the salt concentration to this level. It is a possibility that other salts were applied as well.

It is also possible that improper irrigation techniques, that is, soil saturation followed by drying will allow capillary movement of salts into the surface where they are concentrated. When one attempts to establish seedlings on such a seedbed the salt concentration is usually higher than the plant can withstand and results in germination and seedling losses.

This appears to be the exact case in point and may explain why many turfgrass plantings are actually lost.

Conclusion

It may be concluded, therefore, that known saline soils should be thoroughly leached to remove many of the dissolved salts down to the level where desirable turfgrass plantings can grow. Also, fertilizer applications should not be so high that it will bring the salt level above the maximum tolerance for the desired plant. This can partially be avoided by thorough incorporation of the fertilizer materials to a depth of approximately 6 inches deep and, naturally, by not applying this high a concentration. Furthermore, irrigation techniques can be practiced to keep most of these salts down below the root zone and, also, keep them in such a dilute concentration that no death losses will occur.

This salt concentration factor becomes an extremely important point in cyanamid fumigation. It has been recommended that upwards of 70 pounds of calcium cyanamid be applied per 1000 square feet, none of which is worked in deeper than 4 inches. Since cyanamid is about 21% nitrogen, an application of 70 pounds per 1000 square feet will leave a residue of 14 pounds of nitrogen per 1000 square feet. Since this is mostly concentrated in the surface, poor moisture relations subsequent to the planting of turfgrasses can result in extreme losses of seedlings. This has been observed by the writer in a number of instances. The safe thing to do, in this case, is to maintain field capacity moisture relations at all times and try to leach some of the surface salts down to a depth of 4 to 6 inches below the root zone of the germinating seedling. If irrigation water is controlled to this degree, the plant roots can still obtain these useful salts at a later date when the plant is stronger and utilize these elements for its own growth and metabolism.—*Northwest Turfgrass Topics, Northwest Turfgrass Association.*

How To Seal Leaking Ponds & Earthworks

by Roy L. Goss

Bentonite clay, a low-cost mineral similar in appearance to ordinary ground clay, is ideal for stopping the seepage of water from ponds and reservoirs, and through dams and other earthen structures. By swelling twelve to fifteen times its dry size, when wetted it fills the tiny voids in porous ground through which water normally seeps.

There are three principal methods of using Bentonite for sealing earthworks. The selection of the best method is dependent upon the conditions present. After reading a description of the three methods, choose the one most applicable.

1. MIXED BLANKET METHOD

Drain the area to be treated and remove the surface rocks and vegetative growth. Fill large holes and crevices with a Bentonite clay-earth mixture made up of one part Bentonite clay to five parts of soil. Plow or disc the area to a depth of four to six inches, and if the soil is wet, let it become fairly dry before proceeding further. If there are deep furrows or other surface irregularities, level with a drag.

Mark off the area into squares ten feet on a side. If the depth of the water will not be over six feet, and the original leakage not too great, use one bag (100 pounds per square). For deeper water, use bag and a half, or when exceptionally severe conditions prevail use two bags per square. These are rules of the thumb. It is best to make the test described in the following paragraph.

Spread the Bentonite clay evenly over the area, and then mix it with the top three or four inches of soil with a disk, spike tooth harrow, or hand rake. Roll or tramp until the original soil density is obtained. The area is then ready to be filled with water. Reports from users indicate an average reduction of seepage of about 86 per cent has been obtained using the mixed blanket method.

In using this method the type of soil is an important factor in determining the proper amount of Bentonite clay needed to stop the water. Fine sandy soils require the least Bentonite clay, while black dirt takes a medium amount. Soils high in clay content do not mix well with Bentonite, and under the conditions it is advisable to follow the pure blanket method.

2. PURE BLANKET METHOD

This method consists of laying a blanket of pure Bentonite clay over the bottom of the pond or reservoir and covering it with three or four inches of soil, sand, or fine gravel. It is the most efficient method, but requires the most care to accomplish. The ground should be smooth and well packed before covering with Bentonite clay. Although one pound of Bentonite per square foot will cover almost all conditions, it is nevertheless advisable to make tests, described a little further in the article. The thin blanket of Bentonite is then covered with a layer of soil, which in turn is compacted to original density.

Large-scale operations using this method have been successfully carried out as follows:

Using a tractor with bulldozer, remove three or four inches from the bottom of the pond and pile the dirt on the banks. Cover the bottom with Bentonite clay, roll it, and put the soil back in the pond. Compact the earth above the Bentonite, and the pond is ready to be refilled. If waders or cattle are expected to walk in the pond, the cover coat should be thicker than four inches. Users report that the average seepage reduction using this method is about 94 per cent.

3. SPRINKLE METHOD

This method is accomplished without draining, and the entire pond does not have to be treated at the same time. Coarse particles of Bentonite are scattered on the surface of the water. They sink to the bottom where they swell, and the resultant gel is drawn into the leaky seams, closing them. The gel formed at the bottom remains in a tenacious layer which is not disturbed by mild currents. This method is not recommended for ponds where the bottom is walked on, except in emergencies to seal sink holes or isolated spots known to be leaking.

When there are areas known to be particularly pervious, these may be treated first and the water loss may thus be reduced to such an extent that the rest of the bottom need not be treated. The sprinkle method will impart a slight temporary cloudiness to the water but will not harm it for drinking purposes. Average reduction in seepage using this method is 75 to 80 per cent.

In all three methods the swelling properties of Bentonite clay are utilized to impede the seepage. Bentonite will not swell in water containing large amounts of salt or acid, and therefore should not be used under those conditions.

GRADES OF BENTONITE

Bentonite clay can often be purchased in two physical types, powdered and granular. Either the powdered or granular may be used for the mixed blanket method, or the pure blanket method. The granular Bentonite naturally should be used where the sprinkle method is employed.

METHOD OF TESTING SOIL SAMPLES TO DETERMINE AMOUNT OF BENTONITE NEEDED

To determine how much Bentonite will be needed several tests should be made, simulating as nearly as possible the actual conditions. There are several ways it may be done. One general method consists of perforating the bottom of a barrel, oil drum, wash tub, or bucket and placing an inch or two of sand and gravel on the bottom, covered by about six inches of average soil packed to normal density, from the area to be treated. Another general method is to imbed a cylindrical object, such as an oil barrel with ends removed, or a stovepipe into the soil to be treated.

When the method of testing has been decided upon, the first experiment should be made with the soil alone to determine the amount or rate of leakage over a twenty-four hour period.

Then proceed with the Bentonite test. If the sprinkle method is to be tried, fill the container with water and sprinkle one-half pound per square foot of granular Bentonite on the surface of the water. Allow twenty-four hours for it to obtain maximum effectiveness, and then check the leakage. If the pure blanket method is to be tried, place one-half pound per square foot of pure Bentonite on the soil, then cover with two or three inches of earth and pack.

(Continued on Page 18)

Turfgrass Abstracts

GALACTOSE- AS TOXIC FACTOR IN DOLLAR SPOT DISEASE. Culture filtrates of *Sclerotinia homoeocarpa* caused extensive degeneration of bent grass root tips. The toxic factor was non-ionic and heat stable. Partial purification of the toxic factor was accomplished using ion-exchange and paper chromatography. The factor was crystallised from acetone and was identified as galactose because it yielded mucic acid following oxidation with nitric acid, osazone identical to that of *d*-galactose, infra-red observation spectra indistinguishable from those of *d*-galactose and the same reactions to various carbohydrate tests as *d*-galactose. In addition, the toxic factor and *d*-galactose could not be differentiated by paper chromatography, were toxic to bent grass roots at the same concentrations, and induced the same reponse by bent grass roots as determined by histological techniques. *D*-galactose caused quick cessation of root elongation and opaqueness of the root tips at less than 30 ppm. When the effect of 14 sugars and 2 sugar alcohols on bent grass roots was studied, only *d*-mannose was comparable in toxicity to *d*-galactose. Galactose accumulated in the culture only when *Sclerotinio homoeocarpa* was grown on basal media with galactose-containing oligosaccharides as the carbon source. Accumulation of galactose in the culture was due to its poor utilisation by the fungus and the preferential utilisation of other sugars hydrolised from the oligosaccharides.

Although galactose causes extensive degenerative effects in roots of bent, cytohistological differences suggest that it is not the toxic component produced by the fungus in the natural state. Malca, I. and Endo, R. M., *Phytopathology,* Vol. 55, No. 7, p. 775.

CORTICIUM DISEASE ON RED FESCUE. Two varieties of creeping red fescue (Pennlawn and Rainier) were grown under identical nutritional regimes at two different times of the year and then inoculated with *Corticium fuciforme.* With the exception of extreme calcium deficiency, observed alternation in disease incidences was found to be the result of multiple interactions of nutritional imbalance, host variety, and time of year the plants were grown.

It was found that disease resistance was lower under conditions of calcium deficiency in both spring and autumn in the case of Rainier and in spring only for Pennlawn. Statistical examination showed that the higher the calcium content of the leaf the lower the incidence of *Corticium.* Nitrogen also had some effect on disease susceptibility — higher nitrogen levels in November-December decreased the incidence of disease whilst the opposite effect was observed in April-May. A study of three soil moisture stress regimes between field capacity and permanent wilting point showed that the Rainier variety allowed to extract to permanent wilting point was more resistant to *Corticium* than that grown near field capacity. No effect was obtained with Pennlawn fescue. Rainier plants grown under high moisture stresses had a decreased level of nitrogen, phosphorus and potash in their leaves. Muse, R. R. and Couch, H. B., *Phytopathology,* Vol. 55, No. 5, p. 507.

DAMAGE BY FAIRY RING FUNGUS. Previous reports of toxin production by *Marasmius oreades* have been confirmed and it appears likely that the toxin is some cyanogenic compound which should be considered an important factor in overall pathogenesis. The mycelium of *Marasmius* growing in vitro produced hydrogen cyanide, a fact which may explain how the fungus can kill all plants within the periphery of the fairy ring. One hypothesis is that the fungus gives off hydrogen cyanide into the soil, and this damages root hairs and epidermal cells. The fungus can then penetrate the damaged roots of otherwise resistant species.

Infested soils which become dry during drought periods are difficult to re-wet. Only a small amount of mycelium occurs in the top 1 in. layer of soil and water enters this zone readily. The 1 in. zone above the infested soil may act as a water seal to restrict the movement of hydrogen cyanide into the atmosphere. The hydrogen cyanide coming into contact with the water may remain in the soil as prussic acid. Under the above conditions the hydrogen cyanide may build up to toxic concentration that would kill all vegetation, thus forming the death zone of the fairy ring. When the fungus dies and the soil again becomes wet, the prussic acid and other cyanogenic compounds may be leached from the root zone. This would again make the area suitable for grass growth. Filer, T. H., *Plant Disease Reporter,* Vol. 49, No. 7, p. 571.

Seedlings of *Festuca rubra, Poa pratensis* and *Agrostis tenuis* were grown under sterile conditions and then inoculated with prepared cultures of the fungus. Three days later fungal infection of the roots was observed. The seedlings received moisture sufficient in amount to eliminate the possibility that moisture deficiency was necessary for fungal infection. Roots were killed or severely damaged by the fungus. It is concluded that *Marasmius oreades* can penetrate the roots of *Agrostis, Poa* and *Festuca* directly, and does not require a natural opening or wound. The mycelium penetrated living cells, and invaded cells are apparently killed by the fungus. Microtome sections of infected grass roots growing in fairy rings in the field also showed that the fungus had penetrated the roots. The mycelium ramified in the cortical cells and destroyed the cell contents. Comparison of healthy and diseased roots showed that the fungus induced increased branching of roots, but the new roots were also destroyed. Filer, T. H., *Phytopathology,* Vol. 55, No. 10, p. 1132.

VARIETAL REACTION OF *AGROSTIS STOLONIFERA* TO STRIPE SMUT. Creeping bent is a host for stripe smut *(Ustilago striiformis).* In an experimental planting of bent varieties at Palos Park, Illinois, stripe smut was noticed on one of the plots in September 1964. The other plots were then examined and the number of smutted plants per sq. yd. was recorded. It was found that the Penncross, Pennlu, Cohansey, Arlington and Congressional varieties of bent were resistant to stripe smut while the varieties Seaside, Washington, Toronto and Evansville showed varying degrees of susceptibility. No serious injury, which could be attributed to the fungus, was noted on the plots. Gaskin, T. A., *The Plant Disease Reporter,* Vol. 49, No. 3, p. 268.

CONTROL OF *TYPHULA* (SNOW MOULD). A series of fungicide evaluations for control of *Typhula* on bent grasses was made at the Rhode Island Experiment Station during the winter of 1963-64 and 1964-65. The trials showed that emphasis should be placed on preventive fungicide treatment before snowfall. Curative mid-winter application is not to be relied on. A particular slow release nitrogenous fertilizer promoted good winter colour. When a mercury salt was incorporated in the granule with urea, good control over *Typhula* was also obtained. Howard, F. L., Adams, P. B. and Jackson, N., *The Golf Course Reporter,* September/October 1965.

COMPARISON OF TOLERANCE TO ICE COVER INJURY BY BENT VARIETIES. Five creeping bent varieties — Toronto, Cohansey, Washington, Penncross and Seaside — plus the Astoria variety of browntop bent, were included in this experiment. Turf plugs of 4 in. diameter were collected and subjected to flooding and freezing treatments to simulate the effects of heavy rain followed by immediate freezing. Cohansey, Toronto and Penncross creeping bents survived 100% after 120 days of ice coverage. Washington and Seaside survived completely through 60 days' coverage with 95 and 85% survival respectively after 120 days. The Astoria bent showed the most injury with only 30% survival after 120 days of ice cover. Beard, J. B., *Agronomy Journal,* Vol. 57, No. 5, p. 513.

WINTER KILL. In North America winter damage is often caused to greens by disease, desiccation, snow or ice. Most of the disease damage is caused by snow mould which occurs particularly after the late use of nitrogenous fertilizers. The favourite fungicides are calomel/corrosive sublimate mixtures. In Canada corrosive sublimate alone is preferred, used at rates up to 6 oz. to 1,000 sq. ft. Injury by drying out is common on windswept greens and in regions where winter rainfall is limited. Is is customary practice to scatter underbrush around the greens in late autumn to hold the snow for winter protection. In the prairie provinces of Canada greens contain a high proportion of annual meadow-grass and drying out used to occur after a thaw in the brief period before it is safe to use the watering system. The modern practice is to cover the greens with polythene sheeting after the snow disappears and so conserve moisture.

Snow is often removed in early spring while the grass is still dormant, but if growth has commenced prior to a late snowfall the snow cover is allowed to remain since a sudden exposure of new tender growth to inclement weather can be fatal. Ice removal is also often undertaken, but it must be done before grass starts to grow under the ice — for the same reason. The ice can be broken up mechanically as soon as it softens at the turf surface, or some greenkeepers prefer to scatter dried sewage sludge or other dark material of fine particle size over the surface of the ice. The black colour aids absorption of the heat of the sun and so speeds up the thaw. Noer, O. J., *The Golf Course Reporter,* March 1965.

ADAPTATION OF TURF GRASSES TO SHADE. Seven individual grasses and eight grass mixtures were grown in a tree-shaded area without irrigation. The findings indicated that it was the micro-environment conducive to disease activity, and not light, moisture or nutrient deficiency which proved to be most significant in affecting grass adaptation to shade. Light deficiencies resulted in reduced density and turf quality but if disease attacks had not occurred the turf would have been adequate. The micro-environment of shade, including higher relative humidity, extended dew periods and reduced light intensity, produced a more succulent type of growth and encouraged disease.

Smooth stalked meadow-grasses were not adapted to intense shade (5% of incident sunlight) due to severe incidence of *Erysiphe graminis.* Red fescue was severely thinned by *Helminthosporium* leaf spot during the first growing season but good recovery occurred the following spring. The severity of *Helminthosporium* attack was reduced in each subsequent year suggesting that susceptible strains of red fescue were being eliminated and the more resistant surviving and increasing. Rough stalked meadow-grass produced a good turf in dry conditions in dense shade for the initial 1½ years but then deteriorated. Tall fescue (var. Kentucky 31) and perennial rye-grass produced unsatisfactory swards throughout the experiment. Mixing of species proved valuable in reducing the effects of disease on any one species in the mixture when grown under shade conditions. Beard, J. B., *Agronomy Journal,* Vol. 57, No. 5, p. 457.

A NEW MEASUREMENT OF GROWTH RESPONSE. The more usual criteria for evaluating grass responses to management include colour, vigour and yield. Another very useful measure of response to management is the ability of the grass to recover from damage or weakness caused by adverse growing conditions. Accordingly, the effect was compared of different maintenance practices on the production of new growing points (buds). Experiments with creeping red fescues, meadow grasses, bent grasses and several other species proved the value of bud count data as a sensitive measure of sports turf response to its environment. Roberts, E. C., *The Golf Course Reporter,* August 1965.

SPORTS TURF RENOVATION BY DEEP AERATION. In 1961 a new technique of deep aeration was tested. Holes ¾ in. in diameter at 2-4 in. centres were made to a depth of 6 in. in old, weak golf greens with the result that significant increases in turf vigour, improvements in appearance, in rooting depth and water infiltration were all achieved. To test further this method of renovating weak, shallow rooted turf, trials were conducted at the Santa Anita Golf Course near Los Angeles. Deep holes were made by hand on the weakest green and backfilled with a variety of compost mixtures. Over-sowing with "Seaside" bentgrass followed. Approximately two weeks after backfilling turf covered the holes and the green was opened for play. Within three weeks the green had to be closed because the turf on adjacent control and machine aerated plots was dying. There was no weakening of turf observed on the deep aeration treatments.

Soil samples taken three months after treatment revealed that there were dense masses of roots to the full 6 in. depth of the holes. There did not appear to be any significant differences in rooting between the various backfilling treatments used. Numerous new roots were also noted in plots machine aerated with ¼ in. diameter holes but very few were seen in undisturbed soil. Root counts and measurements of water intake and oxygen diffusion rates indicated that compacted soil on golf and bowling greens can be greatly improved by deep aeration. Before treatments were applied the sward of the experimental green was 50% annual meadow-grass. After deep aeration and over-seeding with creeping bent the bent could be seen growing over the aeration holes and a significant decrease in the proportion of annual meadow-grass in the sward was noted. Morgan, W. C., Letey, J. and Stolzy, L. H., *Agronomy Journal,* Vol. 57, No. 5, p. 494.

MULCHES. The effect of various mulching materials, with and without irrigation, on microclimate and seedling establishment were studied. Straw, sawdust, wood fibre cellulose, elastic emulsion and a control using no mulch at all were studied with smooth stalked meadow-grass, tall fescue and redtop bent. Night and day soil temperatures and seedling emergence, height, density, weight, and soil moisture were recorded.

Straw, sawdust and wood fibre cellulose mulches moderated the soil temperature of the seed zone, thereby improving germination, emergence and growth of grass seedlings. The elastic emulsion was not beneficial to grass development. Straw mulch tended to moderate soil temperature and to conserve more soil moisture than the other mulches but not significantly more when compared with wood fibre cellulose. Weed seedlings present in the straw mulch caused much reduced grass seedling weights. Sawdust improved turf establishment but was easily washed off gentle slopes during heavy rain. Wood fibre cellulose eliminated the introduction of undesirable plant species, had a favourable influence on soil temperature and moisture and increased the rate of seedling germination, emergence and growth. Barclay, D. G., Blaser, R. E. and Schmidt, R. E. *Agronomy Journal,* Vol. 57, No. 2, p. 189.

CONTROL OF "THATCH". A long term investigation into the causes and control of "thatch" build-up is in progress at Michigan Agricultural Experiment Station. "Thatch" is defined as a tightly intermingled layer of living and dead plant tissue which develops between the layer of green vegetation and the soil surface. Relevant factors being considered include cutting height, cuttings returned or boxed off, mechanical fibre removal and six rates of nitrogen fertilization, in various combinations. A layer of fibre more than ½ in. thick is thought to cause turf deterioration because it favours disease activity, reduces drought resistance and inhibits the penetration of air and water into the soil. Higher rates of nitrogenous fertilization, the development of more vigorous grass varieties, increase in watering and the relatively cool climate which allows grass to grow all summer in this part of the U.S.A. are all considered to have contributed to the current prominence of the thatch problem in Michigan. The specific causes of thatch formation are not yet well understood but the condition is thought to be favoured by acidic soil conditions, the return of cuttings, excessive nitrogenous fertilization, intensive irrigation and heavy clay soils. Nelson, L., *Michigan Turf Grass Report,* Vol. 3, No. 1, p. 8.

EFFECT OF CLIPPING ON INVASION OF PASTURES BY YORKSHIRE FOG. It was found at the Oregon Experiment Station that intercepting one-third or more of the incoming light significantly reduces the growth of Yorkshire fog seedlings. Seedlings planted late were less able to survive the winter than were larger seedlings. To determine whether controlled clipping could be used to control Yorkshire fog, this grass was sown into stands of perennial ryegrass, cocksfoot, tall fescue and meadow foxtail. The grasses were then clipped at two different heights and at two different frequencies. Establishment and growth of Yorkshire fog seedlings were favoured by more frequent clipping during the growing season but were retarded by infrequent and high cutting. It was concluded that the invasion of pastures by Yorkshire fog could apparently be retarded if grazing were managed so as to maintain a nearly complete plant cover over the ground at all times. Hart, R. H. and McGuire, W. S., *Agronomy Journal,* Vol. 56, No. 2, p. 187.

PRE-EMERGENCE CONTROL OF ANNUAL BLUEGRASS. A study was carried out at the Western Washington Experiment Station to investigate chemicals known to inhibit the establishment of annual bluegrass seedlings and to determine their residual effects. Experiments were carried out under an air-supported plastic greenhouse on 1 ft. square plots sown with annual bluegrass and browntop bent, the plot being pre-treated with the various chemicals one day, 3, 6 and 9 weeks before sowing. It was found that Casoron, Fenac, Dacthal, Zytron and Dipropalin significantly inhibited the development of annual bluegrass, new growth being prevented for a long as six weeks with Zytron. Casoron had the longest residual effect but unfortunately also exhibited extreme phytotoxicity. In the second experiment, Dacthal, Fenac, and Zytron showed significant control after twelve weeks, seedlings being yellow and stunned. All the above chemicals were non-toxic to mature grasses.

The chemicals were found to prevent the establishment of seedling grass by inhibiting root growth. Seedlings removed from treated plots had markedly reduced root systems, the young bent plants being more seriousy affected than the annual bluegrass.

It was concluded that present-day pre-emergence herbicides for the control of annual bluegrass are not without promise but have several limitations. Their toxicity to bent seedlings, for instance, limits their use to established turf and prevents over-seeding with bent during the period of residual activity. Goss, R. L., *The Golf Course Reporter,* March 1965.

SEASONAL ABILITY OF HERBICIDES. Paraquat, Dalapon and Amitrole-T were compared as to their ability to kill a long established *Agrostis/Lolium* pasture in late July, late October and early April. Paraquat at 0.75, 1.5 and 3.0 lb. per acre and Dalapon at 10.0 and 15.0 lb. per acre destroyed the sward most successfully but Dalapon was not efficient at the April spraying. Amitrole-T at 4 lb. per acre had the ability to cause the sward severe chlorosis and to kill most broad-leaved species but failed to achieve a substantial kill of grass at the three dates. Paraquat was judged the most efficient chemical, being non-residual and most rapid in action at all dates of application.

The results obtained suggest that the composition of the new growth on treated areas may be decided by choice of chemical and influenced by time of application. Considerable reductions were achieved

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ABSTRACTS (Continued)

in the amount of *Agrostis stolonifera* re-colonizing the plots after the July application of all three chemicals, but the autumn and spring treatments resulted in strong re-establishment by this species. A substantial increase in *Lolium perenne* resulted from July applications and this was most marked following the treatment with Dalapon at 5 lb. per acre. *Poa trivialis,* though initially susceptible to all the July treatments, was the major component of swards treated with Paraquat at 0.75 and 1.5 and Dalapon at 10 lb. per acre by the following November, but occurred less frequently on plots treated with Amitrole-T. October applications of all chemicals reduced the content of *Poa trivialis* in the re-growth. In the case of *Holcus lanatus,* reduced amounts of this grass occurred in November on plots treated with Dalapon and Paraquat in July. On the other hand, the regrowth after treatment with Amitrole-T contained considerably increased quantities. Allen, G. P., *Weed Research,* Vol. 5, No. 3, p. 237.

EARTHWORKS (Continued)

If the mixed blanket method is to be tried, mix one-half pound per square foot of Bentonite with the top two inches of earth and pack.

The purpose of these tests is to determine the minimum amount of Bentonite needed to effectively stop leakage. Make a second test using either 20% more or less Bentonite, depending upon the results of the initial test. Repeat this procedure until the minimum amount in pounds per square foot has been established. This amount, which will be approximately one-half that recommended in previous paragraphs, should then be double for use on the actual project. This is necessary in order to compensate for the greater head of water in the actual pond, and for the greater evenness and precision with which Bentonite can be placed in a small-scale test.

The methods outlined above should save many people with ponds in various places, whether they be in parks, golf courses, recreational areas, or even on farms, a lot of trouble with water loss. It would be surprising if you actually knew how many millions of gallons of water are lost annually from leaking ponds and reservoirs.

POLYETHYLENE LINERS

Polyethylene sheets have been used effectively in many instances for stopping leaking ponds. One has to be extremely careful in using polyethylene since any puncturing of the lining material can result in considerable leaking. Polyethylene, of course, must be covered with several inches of soil to prevent puncturing from accidental means, or by people wading into the pond areas.

Many other materials are available and have been tried for stopping pond leaking, but the two described above seem to be the most practical.—*Northwest Turf Topics, Northwest Turf Association.*

Q. What tools are available for aeration of small lawns?

A garden fork can be used for this purpose, but it is laborious to use. Small equipment for home lawns is now on the market, and larger pieces of equipment can sometimes be rented.

Diagnosing Problems On Golf Courses

by O. J. Noer

Golf has been the pioneer in the search for better grass because the game is played on turf. Requirements for a pleasant game are more exacting than for any other sport played on grass, with the exception of tennis and bowling greens.

At the start, golf clubs employed a Scotsman or an Englishman as the professional to teach members the game of golf. Automatically, turf-grass management became a part of his duties on the assumption that he was equally proficient in that field. These pros were golfers mostly, usually without actual experience or background knowledge of maintenance. Those with experience gained it in Britain under vastly different climatic conditions. Some did well, but many could not cope with the more complex problems in America. Unfortunately, they had no place to obtain help when in trouble, which was quite often.

The search for the answer to a perplexing turfgrass problem started forty years ago. Grass on the greens at Columbia Country Club in Washington, D. C., was wiped out suddenly just prior to a National Open Tournament. The loss aroused Dr. Harbin of that club and others to enlist help. They turned to the U.S.G.A. The result was the formation of the Green Section as a co-operative venture with the United States Department of Agriculture. Dr. C. V. Piper served as first Director, in addition to his other duties with the U.S.G.A. Dr. John Monteith, Jr., the first recipient of the Green Section Award, was assigned the task of determining what happened to the grass on the greens at Columbia and to find an answer. Fortunately, he was a trained Plant Pathologist. Monteith identified the organisms responsible for brown patch and dollar spot first, and snow mold later. He originated the 2/3 calomel, 1/3 corrosive sublimate mixture for disease control and saved the day. This fungicide has stood the test of time and is still best in the minds of some.

A few years later the grub of the Japanese beetle threatened to exterminate every blade of grass in the Philadelphia and surrounding territory. Superintendents tried to kill the grubs by rolling. Others tried carbon disulfide. It damaged the turf more than the grubs, if that was possible. Finally, R. B. Leach of the U.S.D.A. was asked to find a safe and sure method of eradication. This was another joint project with the U.S.G.A. Leach soon devised the lead arsenate method of control. It saved golf course turf.

Leach noticed the absence of crab grass and lesser amounts of *poa annua* on the lead arsenate treated plots. As a result he dramatically prophesied the end to hand weeding. His remarks stimulated interest in selective weed control. Fred Grau, a Green Section staff member, was assigned to study this promising project. He added arsenic acid and sodium arsenite to the list of selective weed killers. They were used extensively and have not been replaced entirely by the newer herbicides.

At another time the stink worm became a menace to the putting surfaces on greens in the New York and Philadelphia districts. Lead Arsenate first, and then the hydrocarbons, such as chlordane, had supplanted mowrath meal and corrosive sublimate

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DIAGNOSING (Continued)

for earth worm control. None of them, at the customary rates, had any effect on the stink worms. Within minutes after poling a green casting was so bad that accurate putting became impossible. To save time, Mr. H. Alfred Langben and Mr. David Goodstein of Quaker Ridge guaranteed a $2500 fund for use by Prof. Schread of Connecticut to find the solution. This he did promptly.

From the time of its inception until sometime after World War II, the Green Section of the U.S.G.A. conducted the only research devoted solely to problems associated with turf. Their extensive experimental plots were situated at the Arlington Garden, now occupied by the Pentagon. It was the only place to obtain authentic information. I for one made it a point to spend a full day on the plots several times each year and have been richly and gratefully rewarded, especially in the early days when there was no other place to go.

Studies at Arlington were with cool season grasses mostly because of location and because of the preponderance of clubs in the north.

Dr. Glen Burton was engaged in pasture grass studies at the Coastal Station in Tifton, Georgia. He was encouraged to enlarge the scope of his investigations and induced to evaluate grasses for golf course use. Clubs in the south now have better grasses because of his pioneer work which was sponsored by the Green Section and the Southern Golf Association.

Turf-grass studies started in New Jersey, Pennsylvania and Rhode Island before World War II. Since then most of the other states have followed suit. Now there are many trained and experienced investigators eager to help solve perplexing turf-grass problems.

Educational facilities have expanded also. At the start there was the 10-week Stockbridge school at Massachusetts inaugurated by the late Prof. L. S. Dickinson. Many successful Superintendents attended this school for the full two year terms. Now turf-grass is a part of the curriculum at many agricultural colleges. The student can complete the four-year course or go on further for an M.S. or Ph.D. degree.

Some think college graduates will be the Superintendents of the future. There will be more, no doubt about that, but they will not be in the majority in the foreseeable future. Those without benefit of college training realize that many of the successful industrial leaders have never been to college. They are self taught and trained. Both have what it takes to succeed.

The national yearly meetings sponsored by the G.C.S.A.A., regional programs such as this one, along with local monthly educational meetings, provide the working Superintendent with ample opportunity to keep abreast with developments in the turf-grass field. Thus the findings of turf-grass research and the results of field testing become common knowledge for intelligent use. How fortunate you are as compared with those of us who date back to the 1920 era.

The first step toward the solution of a turf-grass problem is an on-site inspection. This may reveal the answer or provide the clue to the solution. An examination of the soil, including physical and chemical features, comes first. Then comes drainage including

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DIAGNOSING (Continued)

surface run-off, sub-surface drainage and air movement. Water management, lime and fertilizer usage, along with disease and insect control, are other important items. Damage can be mechanical or from improper mowing. Faulty use of fertilizer, insecticides, fungicides and herbicides can be the culprit. Thatched turf and tree roots in greens, tees and even in fairways, where trees are numerous in the rough alongside the edge of fairways, can be the cause of unbelievably bad turf.

It is important to distinguish the primary cause and not be misled by something that is secondary. Helminthisporium leaf spot is blamed sometimes. It may be the cause of damage, but iron chlorosis weakened the grass. This enabled leaf spot to flourish. Had the iron chlorosis been stopped promptly there would have been no leaf spot or injury. This is a specific case and not intended to imply that it is the only reason for leaf spot.

One or two examples illustrate the advantage of an on-site inspection. During a visit to Los Angeles, crab grass was cited as a huge problem on the fairways at one of the prominent clubs. This did not seem to make sense because a good bermuda turf there should resist invasion. There were large patches of a creeping weed in the fairways. It was identified as of the fennel type. It flourished in winter but weakened in hot weather. Then crab grass took possession of these areas. The final solution was to use enough fertilizer to foster growth of the bermuda, and then follow with sodium arsenite to hold the crab grass in check. This was tried on two areas first and then adopted when the results proved the merit of this procedure. Once fairways became dense, tight bermuda turf, crab grass ceased to be troublesome.

The roughs at a Georgia course were crab grass without any bermuda of consequence. The use of a pre-emergence herbicide was suggested. That did not seem like the best answer because there would be bare ground until May or June when weather would be favorable for bermuda growth. The final program involved using dolomitic lime to reduce soil acidity and provide needed magnesium. In May enough sodium arsenite was used to kill the crab grass. Generous fertilization followed. The contemplated seeding with Arizona seed never occurred. There was enough bermuda to make cover with fertilizer, light sodium arsenite treatments to hold crab grass in check and water during periods of dry weather. By fall there was a good cover of desirable grass.

Bermuda on the greens at Tarlac in the Philippines was bad. Iron chlorosis was the cause. An application of ferrous sulfate made a tremendous difference. The change occurred in less than 12 hours. Nevertheless it was hard for the natives to accept such a simple answer, yet they continued to spray as directed. Several months later the man in charge of maintenance wrote to report that the grass now has a pleasing green color and there had been a marked improvement in grass density.

There is a notion that the Superintendent should be self sufficient. This feeling is fading. Big business turns to specialists to help solve problems. The Sewerage Commission used them from time to time. The staff may have had a better grasp of the problem. Despite that fact the specialists were helpful. The wise Superintendent does the same thing. His problem is to choose wisely, and select a person, or organization with integrity, sound judgement and wide first-hand experience with turf management. The Green Section, or the staff of the state Experiment Station where there is a member with turf experience, fulfill these requirements.

Young Superintendents possess the enthusiasm of youth. They are pront to ignore their elders. At times they are justified, but that is the exception rather than the rule. Experience is a valuable teacher. Advice from an able older man can save a headache or two. The man to respect is the one who retains the enthusiasm of youth throughout his active years. My background training was good, possibly above average, for which I am indebted to Prof. Truog. He urged me to become well grounded in the basic sciences. That training was to provide the tools to find the logical answer and solution to everyday problems. When I ventured into the turf-grass field I knew nothing about grass or the practical aspects of its management. I made it a point to know the older men in the profession and leaned on those who seemed best qualified. I owe them a big debt of gratitude for the help they gave me. In turn I tried to show them some of the reasons for the things they were doing.

A new revolutionary suggestion should not be adopted on a large scale until tested to find out if it is the answer, or better than something that has stood the test of time. The tendency to resist change is understandable. Tradition is wonderful but does not lend itself to progress. The English poet Pope suggests:

> "Be not the first by whom the new are tried
> Nor yet the last to lay the old aside."

This is the kind of attitude that makes for progress. The impossible of today becomes the commonplace of tomorrow. We must recognize that and be ready to evaluate advances and adopt the ones that fit our program to make the golf course an even better place for the players.—*Turf Conference, University of Florida.*

Q. What special care is required for a Bent lawn?

To be at its best, Bent grass must be clipped at a height of cut of one-half to one inch. Putting-green mowers are usually required for this clipping, but many ordinary mowers can be set to cut almost this low. Summer watering is almost always necessary. Occasional brushing of the Bent is beneficial with a stable broom or brush attachment on the mower to prevent matting. Yearly or twice-yearly top-dressing with a screened top-soil is often required, particularly when the lawn is young. Bent lawns are subject to attack by fungus diseases. Therefore, periodic applications of fungicide are required in summer and also in late fall to prevent the Snowmold fungus from damaging the turf. It should be noted that 2,4-D, at rates given on the containers, cannot be used safely on bent lawns.

Subirrigation Of Turf[1]

E. H. STEWART, E. O. BURT AND R. R. SMALLEY[2]

INTRODUCTION

Subirrigation as discussed in this report is defined as applying water to the root zone of the crop directly from a conveyance system or indirectly by water table control.

Irrigation by water table control through use of surface ditches is practiced extensively in parts of California and Colorado, and in the Flatwoods and organic soils of Florida Coastal Plains (2). Also, some areas of the Netherlands (2) use underground pipe systems for subirrigation and drainage. Mole channels for subirrigation and drainage in combination with surface ditches are being used to some extent on organic and clay soils.

The requirements for different types of surface and subsurface irrigation are discussed by Houk (1). A comparison of sprinkler and gravity irrigation with regard to physical characteristics, water requirements, and economics has been made by Stevens (4).

The three methods of subirrigation evaluated at the Plantation Field Laboratory, Fort Lauderdale, Fla., and discussed in this paper are: (a) controlled water table, (b) porous tile, and (c) perforated plastic pipe.

PROCEDURE AND RESULTS

Water table irrigation

Evapotranspirometers (3) were used to study the effects of water table level on water consumption, yield and quality of Bitter Blue St. Augustine grass and Tifway bermudagrass grown on Arzell fine sand. Each grass was grown for 3 years with water tables maintained at 12, 24, and 36 inches below ground surface. Water was added or removed daily as necessary to maintain the desired water tables. Recommended fertilization, clipping and other management practices for general lawn purposes were used.

St. Augustine grass appeared to grow equally well at all three water table levels. Annual yield of forage was not affected by depth of water table, but protein content of St. Augustine grass was significantly reduced where water tables were maintained at the 12-inch depth as compared with 24- and 36-inch depths (Table 1). Annual evapotranspiration (ET) by St. Augustine grass was not significantly affected by depth to water table. However, during periods of no rainfall ET was about 21 percent less from the 36-inch water table than from the 12- and 24-inch water tables.

Tifway bermudagrass was established on the evapotranspirometers following 3 years of St. Augustine grass and 1 year of grain sorghum. Average vegetative yield for the first year of bermudagrass was about 50 percent greater from the 24- and 36-inch water table than from the 12-inch water table. The quality or general appearance of the grass in the 24- and 36-inch water table plots was markedly better than on the 12-inch plots indicating a poorer growth environment with the 12-inch water table. This may have been due to insufficient aeration and increased disease incidence. The surface of the soil stayed moist on the 12-inch plots, whereas it was dry most of the time on the 24- and 36-inch water table indicating capillary movement of water above the water table is between 12 and 24 inches for this soil.

Average evapotranspiration of the two sod crops over a 6-year period was about 43 inches of water per year. During an extended dry period of 6 weeks, evapotranspiration of bermudagrass was about 23 percent less from the 36-inch water table plots than from the 12-inch water table plots.

The 12-inch water table treatment gave significant frost protection in December 1962. The frost damage ranged from practically no injury on the 12-inch plots to a nearly complete kill of aerial growth on the 36-inch water table plots. Frost protection by high water tables is an important factor for consideration where water table control is possible. Protecting quality sod during inclement weather is important to the turf grower as well as the user.

Porous tile irrigation

The irrigation principle in this study with porous tile involves the movement of water through the walls of the tile by gravity flow. The porous tiles were about 12 inches long, cylindrical, with an average outside diameter of 1⅛ inches and inside diameter of ⅝ inch. The tiles were connected to the water system and to each other with 11/16 inch polyvinylchloride (PVC) tubing and placed on 36-inch centers at a depth of 10 inches below the soil surface. Tifway bermudagrass sod was established on the test area by sprigging in 12-inch rows. A control box utilizing a needle valve and float mechanism to maintain a constant head of 26 inches of water was used to regulate the water supply for the porous tile irrigation system. The flow rate of each experimental tile was determined by laboratory methods. Percent distribution of the flow rates of the 600 tiles. The tiles were grouped by replicates in the irrigation test to give aveage flow rates of 0.45, 0.70, 1.14, and 1.85 inches per day, based on the laboratory tests. Each plot consisted of 25 tiles in an area 15 feet square.

Tile flow rates decreased rapidly the first week of operation, leveling off at about 0.065 inches per day. During the first year the flow rate averaged about 0.045 inch per day, which was inadequate for optimum growth of the bermudagrass. Laboratory tests showed that organic and inorganic deposition on the inner surface of the tile was causing this decreased flow rate. Treating the tiles with sulfur dioxide gas and dilute acids partially corrected the problem but only temporarily. Further studies indicated that the greatest problem was due to a heavy coating or growth of filamentous water bacteria. Treating the water with sodium hypochlorite (300 ppm by wt. of NaOCl) to control or prevent bacterial growth in the tile was effective in reducing clogging

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[1] Florida Agricultural Experiment Stations Journal Series No. 2303. Contribution from the So. Branch, Soil & Water Conservation Research Div., Agricultural Research Service, U.S.D.A., and Plantation Field Lab., Everglades Experiment Station, Fla. Agr. Exp. Stations, in cooperation with the Central and Southern Florida Flood Control District.

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SUBIRRIGATION (Continued)

of the new tiles as well as increasing the flow rate of clogged tiles. Tiles that had become clogged with bacterial growth when using untreated distilled water (mineral free) were further tested with the same water treated to control bacterial growth. Within a week the tile flow rate, which had dropped to 0.04 inch per day using untreated water, increased to 0.20 inch per day with treated water. This demonstrates that bacterial growth can play a predominant role in the clogging of porous tile used for subirrigation. Several tiles having initial flow rates greater than 0.40 inch per day were tested in the laboratory with treated (chlorinated with NaOCI) well water having a high mineral content. These tiles maintained a flow rate of 0.20 inch or more per day for over 6 months, although there was deposition of significant amounts of inorganic materials. The inorganic deposits can be readily dissolved with dilute acids and apparently will not present as much of a problem as the bacterial growth.

Perforated pipe irrigation

This subirrigation system utilized perforated high-density polyethylene pipe which delivers water to the root area at points on 30-inch centers and 5 inches below the surface. Trenches 2½ inches wide and 8 inches deep were dug and 3 inches of pea gravel placed in the bottom of the trench. The perforated pipe was placed on the pea rock 5 inches below the soil surface. The system was installed in a Tifway bermudagrass sod by placing the ½-inch pipe in 30-inch rows and connecting them to a ¾-inch closed perimeter line with high-impact polystyrene insert fittings which provide a tight fit without use of adhesive or clamps. Perforations in the ½-inch pipe were 30 inches apart and 1/16 inch in diameter. After testing to see if all perforations were open and flowing freely the pipe was turned so that the holes were on the bottom and then covered with soil.

The perforated pipe in the system was under pressure ranging from 5 to 8 psi. under normal operations. The irrigation rate of the system at different pressures as measured at a central point in the system. Water used in the system was pumped from a shallow 15-foot wel through a standard sand point screen.

Results over a period of a year indicated that, with water pressure of about 6 psi. at the pipe orifices, the system supplied an inch of water per hour to the area (1,000 sq. ft.). There has been no noticeable decrease in flow rate of water through the system which would indicate no significant clogging of the perforations by roots or other foreign materials. However, lateral soil moisture distribution in the Arzell fine sand in which the system is installed was quite variable in the 0- to 6-inch soil layer after irrigation. This soil is very difficult and slow to wet when nearly air dry. Under these conditions limited capillary movement of water is due primarily to resistance of the soil to wetting.

The problem of lateral capillary movement of water in the upper root zone in deep sandy soils is of major importance with this type of irrigation system. Increasing the wettability of soil by the use of wetting agents or providing a barrier that increases lateral movement would increase the effectiveness of this type of subirrigation. The use of barrier materials such as plastic sheeting or a layer of fine-textured soil is a possible solution to the problem.

SUMMARY

Three systems of subirrigation were evaluated for use in turf. These included (1) controlled water table, (2) porous clay tile, and (3) perforated pipe. Each of these methods of subirrigation has its advantages and limitations. The primary limitation of the controlled water table system is the necessity for a relatively impervious layer on which the water table may be maintained at a desired level, or a natural occurring high-water table. The primary problem encountered with the porous tile system was found to be clogging of the tile pores with organic and/or inorganic materials. The perforated pipe system was limited by inadequate distribution of water in the upper root zone of this coarse textured soil. Recognizing these limitations and capitalizing on the advantages of the best system for the particular conditions under which the system is to be used may be a satisfactory approach to subirrigation.

TABLE 1. YIELD AND PROTEIN CONTENT OF ST. AUGUSTINE GRASS GROWN AT THREE WATER TABLE LEVELS.

Water table level inches	Yield of dry forage* lb. per acre	Protein content** per cent
12	45,600	8.25
24	46,500	9.91
36	43,900	10.54

* Total yield for a 30-month period.

** Average protein content of 11 clippings.

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—*Turfgrass Conference, University of Florida*

Q. How can small quantities of materials be evenly distributed?

Small quantities of materials such as nitrogenous fertilizers, insecticides and herbicides can be applied evenly in dry form by mixing them thoroughly with some carrier such as dry screened sand or soil or an organic fertilizer. A pailful of carrier is a convenient amount to use per 1000 square feet. The mixture can then be spread with a fertilizer spreader or broadcast evenly by hand. Thoroughness of mixing is just as important as evenness of spread.

Liquid materials and materials that are soluble in water can be dissolved in water and applied as sprays. There are many types of small sprayers on the market for this purpose and also devices for attaching to a garden hose. These devices release the correct proportion of material into the stream of water coming through the hose. On small lawns, an ordinary watering can with a rose-spray nozzle can be used to make an even distribution of soluble materials.

Where-O-Wear

Roger J. Thomas[1]

Our subject involves the wide field of preventive maintenance of equipment and because it is a broad field I will dwell briefly on the main problems of where excesive wear occurs. They are typical of the conditions that cause exceptional wear on both turf and equipment.

Even the best-kept courses have wear around greens and tees. In some cases where play is excessive tee-off markers have to be moved more than once during the day. Some golf courses experience more general turf wear than others. The introduction of golf cars has caused some undue amounts of wear. To avoid a situation where the tracks are showing and the ground is barren of grass it may be well to rope off car paths, establish golf car parking areas and, if possible, try to guide the traffic either by ropes or signs. If you don't, chances are you are going to be involved in a great deal of extra work.

When the area becomes barren laying down sod is an answer. It is fast and produces turf immediately, which is eye catching to the golfer and certainly fills the need for having a turf-covered area. Sod makes an excellent cover when it is needed at a *time* that is *difficult* to grow grass from seed or stolens.

The turf area you see in this slide was planted in early September and, while this is a good planting time in this climate, the turf never did get a start before the football players and the track team started working out on it. So if you can, plan your planting time away from periods when you expect heavy traffic. Turf damage can also be done by excessive amounts of rain or by golfers who disrespect the golf course — some even build temporary bridges. One course that did not have good drainage managed to salvage a lot of turf by putting signs on the tees, warning people of the locations of heavy accumulations of water.

Sometimes the way a car path or sidewalk is constructed can cause wear on turf. If you intend to put in a car path or walk and wish to narrow it down to a single lane, then do so gradually. Undue wear on both equipment and sand traps can be caused by improper operation of equipment. A good *training* program will help eliminate some unnecessary turf damage done by operators handling equipment in the "tough-to-mow" places. Turf equipment can be damaged, too, unless ramps are made to mount curbs. Hydraulic lift equipment should seriously be considered when purchasing mowers that must move over curbings or travel over cemented areas. As can be seen here, poor drainage can cause undue wear on turf and exposed drains can be very hard on mowers. If you have an exposed drainage sewer on the course, it may be best to decorate the area and not attempt to cut close to it.

Be aware of all the adjustments on every piece of equipment and then assign someone to make the proper periodic checks. Some problems can come from improper repair as well. Here is an example of a sprocket that should have been replaced at the same time that the new chain was installed. Actually both will wear excessively now and the chain life will be shortened considerably.

Sounds are very important in any preventive maintenance program. Here is an example of a set of gears that howled for nearly 50 hours because of a lack of lubrication. At any point during this period had 3 ounces of oil been placed in the housing, the gears would have been saved. Sounds play an important part with regards to bearings and maintenance procedures. Bearings will howl or whistle when they lack lubrication or when they are beginning to wear badly. Immediate replacement of these bearings can save the equipment; however, if one disregards the sound, costly repairs will follow.

Follow the manufacturer's recommendations on speeds of *engines* and in the *operation* of equipment. Speeding up an engine beyond the recommended limits cannot permanently solve a problem of "lack of power." As you can view in this slide, excessive speeds of towed equipment can also cause bent or broken pawls. Damage will be done to other parts of a piece of equipment if the recommended travel limits are disregarded.

Clean air cleaners lead to better performance of the engine and dirt, such as you see here, certainly doesn't contribute to longer life. Air cleaners operate efficiently only for a very short time so replacement or cleaning is necessary in order to get maximum performance from a piece of equipment. Engines will not burn dirt and the air cleaner determines the amount of dirt that passes through the engine. Since most engines we use around the golf course, with the exception of our tractors, are air cooled we must keep the fins clean to permit air to pass through and cool the cylinders. Extreme heats are built up and seizures or rapid wear take place on the piston and cylinder. In case of tractors, radiators must be kept clear of debris. This piston shows the results of overheating and a dirty air cleaner. In some areas of the country an engine can be worn out in a few hours by removing the air cleaner. Seizures of engines will cause stripping of the metal on the piston and cylinder wall resulting in costly repairs.

With the chemicals and fertilizers being put on turf today, the washing down of equipment is very important. The dirt you see accumulated on this machine consists of lime and acid that will certainly reduce the life of the equipment. 'Tote' boxes mounted on equipment, such as this, certainly will not contribute to the top performance of a piece of equipment. Alert your workers to observe equipment for missing parts, such as gas caps, loose bolts and nuts, missing shields or covers.

Using the recommended fuels for engines is extremely important. Here is an example of a 2-cycle engine spark plug, in which ethyl gasoline was combined with a detergent oil. The combination causes the formation of carbon pellets which results in spark plug fouling. Improper oils can also cause other problems. Excessive carbon can build up on a piston or in the ring grooves such as you see on this slide. Use the manufacturer's recommended oils prescribed for each application. Contributing to wear of a product is dirty oil. Change the oil filters on your tractors if the filter is dirty, even if the number of hours in use does not call for replacement. If the oil reservoir is dirty, think of it as supplying a lapping compound to the engine and I am sure you will decide to change the oil more often.

(Continued on Back Page)

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[1] Jacobsen Manufacturing Co., Racine, Wisconsin

[2] Ed. note: Slides used throughout this presentation could not be reproduced in this volume.

FROM

MASSACHUSETTS TURF AND LAWN GRASS COUNCIL
INCORPORATED

RFD #2, HADLEY, MASS. 01035

TURF BULLETIN

TROLLING

PESTICIDE (Continued)

indicates that vomiting induced "under proper and controlled conditions at the Centers, as well as the forceful ejection of vomitus produced by syrup of ipecac, may be contributing factors to the low incidence of pneumonitis of less than one per cent for hydrocarbon (petroleum distillates and turpentine) ingestion cases in which this drug was used."

A second report by Doctors J. J. Alpert and M. C. Heagarty, Boston Poison Information Center, gives some data obtained from a campaign to place a bottle of ipecac syrup in homes (a prescription was still required at that time — Poison Prevention Week, 1965).

Such a campaign needs our continuing support.

MACHINERY (Continued)

Training is extremely important even to the extent of training mechanics and others to use the safety devices provided, such as grinding shields or safety glasses. Take some time to teach the limitations of equipment to avoid accidents and be sure you personally check to see that the equipment purchased can be transported anywhere that an operator is required to go. Be certain that you tell any new operators about certain cutting conditions that may affect equipment and point out such items as sprinkler heads, drainage ditches, or mowing areas that present unique problems.

Keeping a record of maintenance costs is important. Review your charts and see where your excessive costs exists. If you don't know the problem, you can't very well find a solution to it. Plan a rainy day program that involves training in all the aspects of preventive maintenance.

Knowing where the wear is occurring can help you set up a good preventive maintenance program. It is not only necessary to train someone to do the job, then assign the job, but follow up to see that it is done. A systematic approach to solving the problems shown today *will* result in reduced costs of operation for the future. — *University of Florida Turf-Grass Management Conference.*

Join Your Massachusetts Turf And Lawn Grass Council

For more information write:

Mass. Turf and Lawn Grass Council
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RFD #2, Hadley, Mass., 01035
or
Contact either of the following:
George Moore, President MTLGC
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Joseph A. Keohane
South East St., Amherst, Mass.

The Massachusetts Turf and Lawn Grass Council is a non-profit corporation. Its officers derive no benefits except the satisfaction of keeping Massachusetts and its neighbors first in turf. It was founded on the principle of "Better Turf Through Research and Education." We must support our University to accomplish this, and we can with a large and strong Turf Council.

Membership is not restricted to Massachusetts residents or turf professionals alone, all are welcome to take part. Write today.

Ed. Note: Answers to questions graciously supplied by Geoffrey Cornish, Golf Course Architect, Amherst, Mass.