# PROCEEDINGS

OF THE

# 9TH ANNUAL NORTHWEST TURF CONFERENCE

STATE COLLEGE OF WASHINGTON

PULLMAN, WASHINGTON

SEPTEMBER 27 - 28, 1955

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Ivan W. Lee and Milt Bauman Turf Association's representatives to Agronomy Advisory Board.

PROGRAM

Tuesday
September 27, 1955

Morning

Compton Union Building, Room 213-214

Chairman, E. G. Schafer, Dean Emeritus, College of Agriculture and Professor of Agronomy Emeritus, WSC.

10:00 - 10:10 --

Welcome. M. T. Buchanan, Director of Experiment Stations, WSC.

10:10 - 10:40 -

What Good is a Soil Test? B. R. Bertramson, Chairman Department of Agronomy, WSC.

10:40 - 11:10 --

Practical Aspects of Leaf Analysis. J. K. Patterson, Department of Agronomy, WSC.

11:10 - 11:30 --

Fertilizer-Fungicides for Snow Mold Control. John Kolb, Toro Manufacturing Company, Minneapolis, Minnesota.

Afternoon

Chairman, Sam Zook, President, Pacific Northwest Turf Association, Waverley Country Club, Portland, Oregon.

1:15 - 2:00 --

Business Meeting.

2:00 - 2:30 --

Golf Course Construction. H. T. Abbott, Supt. of Parks, Spokane, Washington.

2:30 - 3:00 --

Sprinkler System Design and Cost. Don Hogan, H. D. Fowler Company Inc., Seattle, Washington.

3:10 - 3:40 -

Landscaping Turf Areas. Carol Wieting, Landscape Contractor. 13504 Twenty-first Street, Seattle 55, Washington.

7:00 --

Banquet. Room 216, Compton Union Building

Wednesday
September 28, 1955

Morning

Compton Union Building, Room 213 - 214

Chairman, L. W. Rasmussen, Department of Agronomy, WSC

8:30 - 9:00 --

Fairy Ring Control. C. J. Gould, Plant Pathologist, Western Washington Experiment Station, Puyallup, Washington.

9:00 - 9:30 --

Golf Green Fertilizer Practices. Sam Zook, Waverley Country Club, Portland, Oregon and Joe Leonard, Clarkston Country Club, Clarkston, Washington.

9:30 - 10:00 --

Fundamentals of Bentgrass Management. Charlie Wilson, Sewerage Commission, City of Milwaukee, Wisconsin.

10:00 - 10:30 --

Pearlwort Control. Dwight Peabody, Agronomist, Northwest Washington Experiment Station, Mount Vernon, and H. M. Austenson, Agronomist, Western Washington Experiment Station, Puyallup, Washington.

10:30 - 10:45 --

Rodent Control. Milt Bauman, Overlake Golf Club, Medina, Wash. and Glen Proctor, Rainier Golf Club, Seattle, Washington.

11:10 - 11:40 --

Merion Bluegrass. Cliff Everhart, Manito Golf & Country Club. Spokane, and Arden Jacklin, Jacklin Seed Company, Dishman, Wash.

Some Practical Aspects of Soil Management. Dr. Fred V. Grau, West Point Products Corporation, West Point, Pennsylvania.

# WHAT GOOD IS A SOIL TEST

B. R. Bertramson, Chairman
Department of Agronomy, Washington State College
Pullman, Washington

Should you have your soils tested? If your greens are like carpets, your fairways and lawns a sight to behold, the answer to the question is "No". You already have the right prescription and are using it. Just as a healthy individual can escape visits to the doctor, you can avoid the ordeals of soil testing for you have no symptoms to diagnose.

In specialized treatment of greens and lawns, one can easily upset the happy balance and get into a peck of trouble. Chances are a lot of guessing will only get you into more trouble. Here is where soil testing really pays off.

Grass on a green or a turf is a very specialized crop. It requires a lot of fertility. For instance, a good yield of clippings from a thousand square feet would be about 100 pounds dry weight per year. These clippings will remove the following amounts of fertilizer and nutrients from the 1000 square feet:

| | |
|---|---|
| Nitrogen (N) | 5 pounds |
| Phosphorus ($P_2O_5$) | 2 pounds |
| Potash ($K_2O$) | 4 pounds |

Obviously to maintain the present fertility level of a soil producing such a crop replacement of these nutrients as fertilizers is required.

When I sat in on your meetings last year, I was amazed at the rates of fertilizer that are used in some of the treatments reported. It takes a lot of fertilizer. On the other hand, because of the rather small areas treated, it is possible to over-fertilize under some circumstances. Perhaps even more likely to cause trouble are the results of putting on fertilizers which tend to leave the soil different in reaction from the unfertilized soil. The ammonia nitrogen fertilizers tend to make the soil acid. The sodium nitrate fertilizers tend to make the soil alkaline and also to destroy soil structure. These tendencies are insignificant in common practices, but if you are putting on tremendous amounts of fertilizers as you do in these highly specialized culture practices the effect upon the soil can be quite appreciable and noticeable in a matter of a few years.

Another treatment on turf and lawns that can give trouble is use of water that is high in calcium or in salts. Water that is loaded with calcium can make the soils alkaline to the extent that it may give you some minor element problems, particularly iron deficiency resulting in iron chlorosis on soils normally neutral in reaction. If the water has an excess of salts in it, these will accumulate and can give you salt problems, which are identifiable by a soil test.

Experience in noting symptoms and a knowledge of what tendencies are likely to develop in an area with certain treatments will help you to diagnose your troubles. But to evaluate the extent of the troubles and the extent of the measures necessary to correct them, nothing can take the place of a good soil test. Where turf performance is all important and the costs of fertilizer used is a minor item, a few dollars spent for soil test is a good investment. Learn to use these tests to guide you in your fertility and watering program. Where problem areas develop, sample these and adjacent good areas so that you can compare the results between the two. In this way, a better diagnosis of the trouble with the poor area is assured. Make clear to the soil testing laboratory that these samples are from the two areas and, therefore, are for comparison. This will help a great deal in diagnosing the troubles and making recommendations for correction.

Use soil tests, don't guess! There remains some skepticism about the validity of soil tests. Just like a doctor's diagnosis, they are no better than the representative nature of the samples taken for the test. To say soil tests are of no use is to say that in 100 years of soil science, we have made no progress; for soil testing is a measure of the practicability of soil science, which is now about 100 years old. Soil testing is the science of measuring and controlling the fertility of the soil through chemistry. Soil tests actually put soil science to work.

Soil testing laboratories of the Land-Grant Institutions of the United States test more than 1,000,000 samples of soil a year. This acceptance of soil testing has largely developed during the last decade. It is real evidence that we are putting soil science to work. While these samples may come largely from fields used for general agriculture or truck crops, the case is even better for diagnosing special, localized soils problems such as you have on greens, lawns, etc.

In particular, what special information can the soil testing laboratory give you from the soil tests?

Soil acidity and alkalinity. These extremes of reactions may arise from the heavy use of fertilizers that tend to develop these conditions. A soil test can easily give the answer if the trend has become a limiting factor in producing excellent turf. Grass is generally quite tolerant to rather broad extremes of soil reaction and, therefore, acidity or alkalinity ordinarily do not pose a serious problem for turf.

Salts are easily determined on a water extract by running conductivities. If a tremendous amount of salt is present, it can be the source of trouble.

Phosphorus and potassium are easily determined and very accurately, too, by the soil testing laboratory. In general, turf makes good use of phosphorus and potassium at what might be considered rather low fertility levels for other crops. However, with the tremendous amounts of these nutrients taken off through clippings, it is necessary to replenish this supply from time to time unless soils are unusually fertile. Soil tests will let you know when you are getting near the bottom of the barrel of soil fertility.

Nitrogen is one of the more critical elements that must be in good supply at all times if turf is to flourish. Unfortunately, it is rather difficult to determine by soil tests whether or not you have an adequate amount of nitrogen tied up with organic matter in such a way that you can count on having a good continuous supply. Organic matter is run by most soil testing laboratories and gives you some indication of the potential supply of available nitrogen. However, anyone who is experienced in growing turf can tell rather quickly whether the grass needs nitrogen. Because of the solubility and rather rapid availability of nitrogen (inorganic) fertilizers, a nitrogen deficiency can be corrected easily and quickly. I expect that Dr. Patterson will tell you considerably more about nitrogen and tissue testing, which is, after all, a better way than soil testing for getting at your nitrogen problem -- if you can't determine the nitrogen status from visual symptoms and your practical experience.

Minor elements? Aside from iron chlorosis on alkaline, or overlimed soils, the minor element problems with turf are usually rare. This is fortunate, because simple rapid tests for these elements are not presently available. The deficiencies can be determined by the more elaborate methods when other diagnostic techniques fail to indicate that the trouble lies elsewhere. Because of their cost and limited chances of providing the answer to turf problems, usually analysis for these are not recommended.

In Washington, there are several commercial soil testing laboratory that can test your soils for you. If one is near you, it may be to your advantage to use it. We also have at Pullman the soil testing service of Washington State College. Our soil testing laboratory can give service on many tests that will help diagnose troubles of greens and lawns. County Agents and Soil Conservation Service Technicians have sample containers available for sending in your samples. They also can advise you how to collect representative soil samples. Dr. C. B. Harston, Soils Extension Specialist, who writes the recommendations, is a turf enthusiast and, hence, gives added attention to such samples. While you are here, I would urge you to visit the soil testing laboratory which is just across the street in Room 11 of Wilson Hall. This laboratory is under the able guidance and supervision of Dr. H. M. Reisenauer. It will be open to visitors all of today. When you have examined the laboratory equipment and discussed some of the complicated techniques and procedures used, you will likely conclude Mike knows his business -- or ought to. I am sure you will find the visit to the lab most worthwhile.

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## PLANT TISSUE TESTS

J. K. Patterson
State College of Washington

Plant tissue tests have been developed by various colleges and commercial concerns in the last 20 years. These tissue test kits are very handy for the practical greenskeeper or landscape man in diagnosing his plant troubles. They have been in use for a number of years by greenskeepers in the mid-west for a greens burning and disease problem encountered during the summer months. Many greenskeepers in that area had noticed that their greens became somewhat brown from the burning of the leaf tip and that many disease organisms became troublesome in the duff of the turf during that time. As a result, some of the greenskeepers began to use plant tissue tests to endeavor to find a reason for these troubles. They found that water from the plant was forced out of the leaf tip during the warm nights and that this water carried a considerable amount of nitrogen. As the water evaporated this left a high concentration of nitrogen which tended to burn the leaf tips and to stimulate the growth of some of the disease organisms in the turf. By use of a plant tissue test, they were able to withhold the use of nitrogen fertilizer until just before the plant would develop a nitrogen deficiency symptom and then supply nitrogen at low enough rates so that it met the plant's needs but did not leave excess nitrogen, which would cause leaf tip burn or rapid development of disease organisms. This is only one instance of many in which a rapid plant test kit can be used by practical greenskeepers in maintaining and developing their management program.

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# FERTILIZER - FUNGICIDES FOR SNOW MOLD CONTROL

John Kolb, Agronomist
Toro Manufacturing Corporation, Minneapolis, Minnesota

Three years ago, Jack Meiners presented a summary of snow mold control studies conducted at Washington State College. In this study, 15 chemicals were evaluated. Calo Clor and PMAS were rated the highest. Calo Clor has, of course, been the most widely used material for snow mold control. PMAS is a relatively "new-comer", but because of certain properties and factors, warrants attention as a snowmold fungicide.

The test which I am going to report on this morning was conducted at Minneapolis, Minnesota, during the winter of 1954-55. Actually, the study was initiated in '53-54, but that season we had no snowmold. Last winter, we were more fortunate -- or perhaps I should say, unfortunate. At least snowmold was very serious in our area this past winter.

Keep in mind that these data represent only one years' results: hence, no definite conclusions may be drawn. However, certain trends which appear significant may be pointed out.

The test was of a randomized block design with three replications. Individual plots were 5' x 10', and the treatments were as follows:

I. Chemicals and Rates

   A. Calo Clor at 2 and 4 oz./1000 sq. ft.
   B. PMAS at 1 1/2 and 3 oz./1000 sq. ft.

II. Carriers

   A. Milorganite
   B. Topdressing
   C. Sharp Sand
   D. Water

Each rate of both chemicals were mixed with each of the four carriers, giving sixteen plots per replication, or a total of 48 plots. The appropriate number of check plots were included.

The materials were applied on November 5. The green had not frozen up at that time. Snow fell one week later and remained.

In addition to the replicated test, Ceresan X and Acti-Dione (experimental) were used on outlying areas of the green. These were simply demonstrational plots and were used primarily to gather a general idea of their performance.

Results and Summary

Readings, based on the actual number of diseased spots, were made on March 11 and April 1, 1955. Snowmold was noted on check plots March 11, 1955. Treated plots showed no infestation, regardless of chemical or carrier.

On April 1, with one exception, the effectiveness of the 1 1/2 oz. rateof PMAS appeared to be considerably reduced - in fact - dissapated. The exception noted was where this rate ( 1 1/2 oz. ) was used with sewage sludge (Milorganite) as a carrier. Both rates of Calo Clor gave effective control, irrespective of carrier, throughout the active period of the snowmold organism.

The 1 1/2 ounce per 1000 rate of PMAS appears to be too light for practical control. Further substantiated by evidence obtained on areas lying outside the test plots which were treated with 1 1/2 ounces of PMAS.

Activated sewage sludge appeared to be the most effective carrier tested. The sewage sludge (carrier) plots exhibited very early greening. Topdressing as a carrier produced similar early greening; however, effectiveness was not as persistent as that obtained with Milorganite.

On March 15, snowmold mycelium were present, on all but three of the twelve plots treated with Milorganite, irrespective of chemical. This infestation was purely superficial in nature and did not develop to the point where the crown was affected. On April 1, no snowmold was evident on these plots.

It should be pointed out that the rate of Milorganite used as a carrier in this test was impractical -- 200 lb./1000; however, we were desirous of learning what effect this exceptionally heavy rate used late in the season had on the turf.

Also, we were interested in learning if this type and amount of organic matter extended the effectiveness of the chemicals used, especially the soluble form of mercury (PMAS). Results to date have shown on deleterious effects on the turf; in fact, beneficial results were obtained. The evidence also strongly suggests that the period of phytotoxicity of the soluble mercury was extended.

I have a series of slides which will show the results of our test this past winter.

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# A LOOK AT MUNICIPAL GOLF COURSE CONSTRUCTION

H. T. Abbott, Park Superintendent
City of Spokane

The subject which has been listed in the schedule for this Ninth Regional Turf Conference would give the impression that in twenty minutes we are going to cover the extensive problem of golf course construction. The other speakers are covering in much detail those important aspects of construction which have a direct bearing on water systems, seeding, landscaping of turfed areas, and management practices, just to mention a few. The chairman of the conference has requested that this discussion be directed at a few of the problems encountered in municipal golf course construction, and the present experience which the Spokane Park Board has in this field of providing public recreation facilities and services. With particular reference to the new Esmeralda Municipal Golf Course, I shall outline in a brief way some of the problems we have met and our manner of solving them.

For many years there has been a growing need for a third municipal course in the growing community of Spokane and the adjacent county. Although Indian Canyon Golf Course had been placed in operation in 1935, the growth of the residential areas has been greater in the north portion of the city and into the Spokane Valley. The selection of a location within the city limits to provide for future golf needs was not easy in view of the fact that these needs were shaping up in areas where little or no land was available for golf course construction. The area north of Minnehaha Park in the northeast section of the city was pointed out twenty years ago by the late Superintendent of Parks, John Duncan, as the ideal site for a third course. Lack of funds until 1947, prevented the city of Spokane from even protecting the public's interest in this part of the city. Following the acquisition of the property through the gift of the Athletic Round Table, some effort was made to start plans. With sufficient funds for a preliminary plan in 1952, the late Francis James was engaged to lay out the course. The sudden death of Mr. James interrupted the plans and for several months nothing was accomplished. Like so many public projects, once the work was started, the interested golfing public wanted the course "now". But there was no possible source of revenue to finance such a project and the plans were not completed in a shape to give an authentic estimate of the costs. Within a few weeks estimates were ready and by agreement with the City Council, a loan from the City General Fund was approved in the amount of approximately $200,000.00 to commence immediately the Esmeralda Course. This cost is to be met by income from the three municipal courses and the estimated time set at 20 years. The initial estimate did not include a complete clubhouse which is now under construction as a gift of the Athletic Round Table.

Reference has been made to the selection of a site in the northeast part of the city. The entire tract is 140 acres of which about 120 acres has been developed as the course proper consists of a gently rolling terrain entirely free of trees or shrubs extending to an eastern boundary well up on the side of a pine covered hill. Because of the steepness of this slope, little of it is usable for fairway construction. For two holes this hillside is used to great advantage, and we trust that the slight inconvenience of walking up one 50 foot difference in elevation won't bring forth demands for an escallator. In general, it is recommended that the minimum for an 18 hole course should be 110 acres, and at Esmeralda the necessity of providing a practice driving range on the course, reduces the playing area to the accepted minimum. The course provides in addition the clubhouse, the practice putting green and automobile parking areas. In the selection of such a site it is essential to take into account the future of the surrounding areas, the zoning for maximum benefit to the course, convenience of access, prevailing winds, and probable season of play. In the case of this particular course, the adjacent residential development is average to below in quality of construction, but there is every possibility of all new homes displaying a higher standard. Much of the adjacent property is as yet undeveloped. The encroachment of manufacturing districts on the north poses a serious threat to the maintenance of ideal golf course conditions, however, revisions to the zoning ordnances governing manufacturing will tend to impose restrictions of a protective nature. The course must be convenient to important traffic arterials with direct access to the residential sections the course is planned to serve. Esmeralda is so situated. Provision has been made to take advantage of the prevailing southerly winds during the daytime and the north wind inversion characteristic during the night hours. Planning for the use of these prevailing winds and night inversion is important for efficient use of the water system to give maximum coverage. The selection of site takes into consideration the character of the soil, the ability of the soil to support playable turf during the longest possible season.

The orientation of Esmeralda is west to southwest and is surrounded on three sides by public streets, boundaries which are desirable for all public recreation areas. The clubhouse is situated on a slight rise at the southwest corner of the course. A large parking area is provided south of the clubhouse to serve both the course and the park area adjacent to the south. In the general design of the course the minimum number of fairways with east-west or northwest orientation has been provided. The necessity of orienting the practice driving course in a north-south direction and conveniently situated for patrons at the clubhouse, required drastic changes in the overall course layout. The requirements of supervision on a municipal course produced an excellent relationship of both starting tees, driving range, and practice putting green. However, like all public recreation areas, only use will finally determine the wisdom of the design.

In the design of the course, the two major considerations have been: economical and profitable maintenance and operation; and maximum golf pleasure and satisfaction for the majority of the golf patrons.

The first of these considerations involves costs which are definitely reflected in the charges to be made to the players. Simplicity of design must be aimed at reducing to a minimum the personnel and equipment required for the best possible maintenance and ease of supervision of play. The reduction or elimination of traps, unnecessary hazards, complicated plantings and intricate water systems is just good business and in the end is indicative of good planning. While municipal courses are not set up with the profit motive in mind, some assurance either through profits or special appropriations should be given that these courses shall be improved or modernized from time to time as needed.

The second of these considerations bolsters the first. Each city should count on having at least one course which is a delight to the average golfer, the patron who is the real supporter of the course. We have been told time and time again that our attention should be directed towards the many few-time players and not the select group of 15% who manage to crack 100. Esmeralda is a course designed to attract the dub. He will not get in trouble in a rough from which he cannot recover. He will not land in any traps at least for the present. He will have very few side hill lies, and he can see where he is supposed to go. Of considerable importance both from the financial and golf pleasure angles is the speed of play. A delayed player is a disgruntled player, and a long waiting line for teeing off can affect the cash register as well.

The clubhouse design is next in importance to the course itself. A poorly designed structure affects the efficient operation of the course, and instead of attracting patrons to participate in what it has to offer, it may appear as an inhospitable admission booth. It should be so planned as to capitalize on the attractive features of the course. It must display in a forceful manner the function of a recreation building with its various assigned activities. Costs vary depending upon the funds available and the intent of the building in the years ahead. A small efficiently planned building is far more successful an investment than a structure twice the size poorly conceived.

The Esmeralda Clubhouse has been designed with these principles in mind. The minimum of supervision will be required to efficiently operate the house. Through unique planning the pro-manager of the golf services at the course has a central point of control in the clubhouse. He is in visual contact as well as by public address system with Nos. 1 and 10 tees and Nos. 9 and 18 greens. He can see and communicate with the driving range.

He can see the practice putting green, the terraces adjacent to the clubhouse, and the main interior itself. He is in a position to control the starting, except on very busy days, because of the central location of the proshop. Parking is planned close to the clubhouse with a minimum of differences in grade, to accomodate the owners of caddy carts.

The mechanics of constructing the course need not be included in this discussion. The problems were not comparable to those courses cut out of undisturbed woodland or laid out through swampy or poorly drained country. A minimum of grading was required inasmuch as the natural gently flowing terrain was desirable. The soil is a gravelly loam with a heavier percentage of sand. Drainage for the most part is excellent. The soil tests were highly satisfactory although the usual deficiency in nitrogen was evident. The greens were entirely built up of a special sandy loam brought in from the north of Spokane. Approximately 6000 yards were required for the greens.

Along the west boundary, in a city street, the water mains serving the northern part of the city afforded all the necessary supply required by the course. After many studies of the various programs for watering such an area, it was concluded that a central water supply would prove most efficient. The system which was finally accepted was a combination of Transite and galvanized iron piping with a booster pump as shown in the drawings on exhibit here today. The design of the system was a down the center of the fairway type, using snap-valves and Buckner 15 and 17 rainers. Outlets are placed at 50' intervals to permit a schedule of watering based on alternation principles. The 4" pump is designed to a capacity of 700 gpm against a head of 15-' (120 P.S.I.). The system has proven highly satisfactory with the exception that unpredictable wind variations have necessitated the introduction of a few laterals for additional areas to be kept green throughout the season. Two water men using a total of 18 Buckner 15 and 9 Buckner 17 rainers take care of this specific detail.

The selection of the seed for this course was determined after consultation with many authorities and I shall say that there is a difference of opinion when it comes to turf grasses. E smeralda being in an exceedingly warm and dry exposure, subject to constant drying winds both warm in summer and cold in winter, it was agreed that the fairways should be sown as late as November of the first year of construction are of astoria bent. Experience has shown that for Spokane climatic conditions, astoria bent can be relied on without qualifications. For the most part these greens are in excellent playable condition at this time. There is no doubt that the tees should be planted entirely to Merion blue grass. The results so far have been very gratifying. Eight tees had been sown with a mixture of Merion and creeping red but these will be changed or converted to straight Merion. All lawn area adjacent to the clubhouse will be Merion blue grass because of its excellent wearing qualities and ability to hold its color throughout the hot summer months.

The problem of establishing trees on the course will be a severe one. In exposed areas it is not easy to develop good specimens. Strong winds, sun scald, injury from golf balls and mowing accidents, and golf tempers, all take their toll on the young trees. The planting of golf courses has been adequately covered in a past session of this conference, and suffice it to say that the selection of trees is very essential. Such varieties as those with silver leaves, annoying fruits, surfacing root systems, brittle structure, and susceptibility to insects and diseases should not be used except in large areas some distance from fairways and greens. Border plantings will be more essential where space between fairways and public roads or residential property is inadequate. Background plantings of greens will often be very ineffective until after many years when the trees have had a chance to gain some size. What varieties shall be used is a matter of local suitability; there are no hard and fast rules.

Finally, a most important adjunct of the course is the service building and the system of service roads. A minimum of roads should be provided on the course and these should be so situated that they do not encroach upon the uses of the greens and their approaches. The building should be centrally located for convenience and properly screened from the fairways. If possible the turf nursery should be a part of the service area rather than at some other part of the course. The question has often been raised about the advisability of planning a quarters for the greenkeeper adjacent to the service area. The ability of the course to provide water and power throughout the winter and to keep access roads open at all times of heavy snow conditions would be a deciding factor. The ideal situation would be for the greenkeeper to be in close contact with the course by having a house on the grounds.

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# TURF SPRINKLER SYSTEM - DESIGN AND MATERIALS

Don Hogan
H. D. Fowler Company, Inc., Seattle, Washington

This paper is not intended to be a short course on how to design a turf sprinkling system, but rather to acquaint you with the problems of sprinkler design, so you might better aid the person doing design work for you should the occasion arise.

Basic Principles to be considered in the design:

First, let us consider what function a turf sprinkling system is intended to perform. Obviously, it must stimulate the moisture that nature fails to give us during the growing season. Therefore, we must artificially either supplement nature's supply, or provide the entire moisture requirements of the soil.

The most important requirement of a turf sprinkler system is that it provide even rates of precipitation over the entire area to be sprinkled. You must remember that the greatest majority of sprinklers that are available on the market today deliver water in a circular pattern. Therefore, we must resolve these circles into various rectangular areas in such a manner that the precipitation rates will nearly be uniform. This is done with proper spacing in order to give overlap to eliminate voids while not overwatering the lapped areas. We recognize that this ideal situation cannot always be achieved, however we do our best to strive for proper distribution and coverage.

A good system will be sized adequately to do the entire job economically without excessive operational labor costs. Nevertheless, we have to design our system to reasonable tolerances for the specific job that is to be done in order to keep our initial installation costs reasonable.

Probably one other requirement that should be mentioned at this time is that a good turf sprinkling system will be versatile to give nearly positive control of the water distribution over the entire area. This means we must be able to provide extra amounts of water to those areas demanding it, while limiting the application to those areas which might be damaged by excessive amounts of water.

Most turf sprinkling systems may be classified into the following categories:

1. Golf Course
2. Cemeteries
3. Parks
4. Play Fields
5. Schools and Commercial building grounds
6. Highway roadside improvements
7. Home lawns

Each one of these systems have their own particular problems and conditions which influence directly the type of sprinkler system they require. For example, most golf courses have many long fairways, each in independent unit from the other, generally of varying widths and seperated or bounded by tree areas or possibly roadways. Naturally, the greens and the tee areas must be treated specially, entirely divorced from the watering of the fairways. Providing adequate moisture for mounds and slopes while not over-watering low areas is of particular concern.

Cemeteries generally give us very irregular areas with limitations as to where pipe lines and sprinklers may be placed. Also interference from monuments and trees can present a decided problem in this type of system. Highway roadside improvements usually have considerable elevation differentials in very short distances, as well as highly irregular and curving areas. Another major problem for roadside sprinkler systems is the lack of adjacent water supply and restrictions to crossing under the highway with pipe lines.

Types of Turf Sprinkler Systems:

1. Portable
2. Selective
3. Manual
4. Fully Automatic
5. Semi-Automatic

Actually, portable systems cannot be classified as turf sprinkling systems. The portable system which generally consists of light weight aluminum pipe to be moved over the area is for agricultural purposes only. This is to say that most turf areas are not capable of accepting moisture as rapidly or to as deep a penetration as cultivated areas. This pipe distributed over an area presents a mowing problem and frequent moves make labor costs prohibitive although initial costs are the least.

The most commonly used of the selective type of sprinkling systems is the hose system. I believe no time need be devoted to the hose system, as no doubt you are all very familiar with this type of sprinkling. Let us say in passing that while the hose system generally gives us the most positive control, it also in most cases is the most expensive to operate and maintain. Another selective type is the quick coupling or snap-valve system. This basically consists of valves beneath the ground surface throughout the area which are constantly under pressure. The operator may then select any of these outlets for his sprinkling operation by merely inserting the coupler, to which the sprinkler is attached, into the valves to put the sprinkler into operation.

A manual system may be described as that system by which batteries of sprinklers are located throughout the area and operated by various control valves. When these valves are operated, a number of sprinklers in a portion of the area operate simultaneously. Naturally, this system has high advantage due to labor saving, however, it will not always give us the positive control we would like to have. Also, you will find that the first cost of this type of system is considerably more than the selective system.

Automatic systems are simply manual systems with automatic control of the valves. These valves being controlled either hydraulically or electrically by a timed mechanism which permits sprinkling of turf without the need of an operator for the system. These automatic controllers are capable of operating each valve independently with varying intervals of time operation. They also may operated both in the first 12-hour period of the day or the second 12-hour period. If required, they also may be adjusted to give more frequent watering. It is possible to cut out not only water periods in a given day, but days in the week. An interesting accessory that may be provided with this type of equipment is a relative humidity measure which will prevent the system from operating, should the moisture concentration in the soil be above a pre-selected amount. Do not discount the possibility of using this equipment, because good design may facilitate the use of this equipment at nearly the same first cost as a manual system.

Semi-Automatic systems give automatic control to operating valves, but selective control to those sprinklers that will be operating. They generally find their use in golf course watering, where three to five quick-coupling sprinklers may be placed on each fairway at the end of the day and the automatic control operates these fairways separately during the night.

## Material Components of Turf Sprinkler System

1. Sprinklers
2. Pipe
3. Valves
4. Fittings
5. Pumps

### Sprinklers

Of all the material that goes into a sprinkler system, possibly the sprinklers themselves dictate more than any other single item as to how the system will be designed. The basic types that we have to draw from are as follows:

1. Spray
2. Rotary Pop-up
3. Positive Drive - long range nozzle type
4. Reaction Drive - long range nozzle type

The spray type sprinkler falls into a classification for use mainly in home lawn systems and finite areas which might be quite irregular in shape and small in size. This sprinkler has a very high rate of precipitation and generally covers an area of 15 to 30 feet.

The rotary pop-up type of sprinkler is considerably longer ranged than the spray type, and is used extensively in the manual type system. This has its most common usage in parks, playfields, cemeteries and larger areas surrounding schools and commercial buildings. Diameters range from 30 to 100 feet.

The long range nozzle sprinkler finds its home mainly on golf courses and other very large areas. This sprinkler adapts itself most readily to the quick coupling type of system. Rates of precipitation will vary generally between 1/4" and 1/2" per hour. This sprinkler covers between 60 and 200 feet.

### Pipe

The most common pipes used in turf sprinkler work are as follows:

1. Wood
2. Steel Tubing
3. Standard Steel, Black and Galvanized
4. Cast Iron
5. Asbestos Cement
6. Plastic

Thirty years ago when most of the golf courses that now are in existence were constructed, wood pipe was one of the most commonly used materials. It has very fine carrying characteristics: however, it is very susceptible to failure due to rot, materials getting between the staves and rusting of the steel reinforcing bands. Steel tubing has been used almost universally in large sprinkling systems. It has the advantage of low initial cost and ease of installation. However, it has a decided disadvantage, in that it has low carrying capacities as well as relatively short life. Standard steel pipe is most commonly found in the 2" and smaller sizes. While this material is quite long lasting, in the thirty year category, its flow generally becomes greatly impaired after ten years of life, due to tuberculation (internal corrosion). Cast iron is one of the most long lived materials available; however, it is one of the most expensive. The cost of laying this pipe is quite high due to its great weight. It also has the disadvantage of being susceptible to corrosion.

Asbestos cement pipe is fast becoming one of the most used materials for sprinkler system piping in the 3" and larger sizes. This is due to its high carrying capacities, and its immunity to corrosion, tuberculation and electrolysis. It is classed with cast iron in longevity.

Plastic pipe is probably the most recent development in sprinkler piping. There are three basic types being used today, namely Polyethylene, Butyrate and Kralastic. Polyethylene is a very flexible, low pressure material, which is quite limited. Butyrate pipe is semi-rigid and has moderate working pressures with very low impact strength. Kralastic pipe appears to be having the greatest success in turf sprinkling systems, in that it has a very high working pressure, high impact, and high ultimate strength. All plastics have a definite advantage in their flexibility, light weight and ease of installation. They also are not susceptible to corrosion, tuberculation or electrolysis, and are rated very high in carrying qualities. I would like to point out that there have been a great number of failures of plastic pipe in sprinkler systems in recent years. This possibly can be traced to mis-application of the material that was used. Therefore, we should not discount this material from usage, but be positive when considering it that the material will have characteristics that withstand the conditions to which they will be exposed.

<u>Valves</u>

1. Gate
2. Angle
3. Quick Coupling
4. Hydraulic

Gate valves are designed for infrequent use for valving off lines, either at the end of the season or to close down for repairs. The angle or globe type of valve is designed for frequent use, and is found as control valves for manual systems. The quick coupling valve, as mentioned before, is used for the specific operation of turning on and off a single sprinkler. The hydraulic valve is best applied to automatic and remote control.

Fittings

It is most important that the fittings used in any system must correlate with the materials being used - that is, they should have the same strength and the same relative life. An example of an inadequate fitting might be a thin gauged galvanized steel tee being inserted in an asbestos cement or cast iron pipe line.

Pumps

The two basic pumps that are generally used in sprinkling systems are the deepwell turbine and the horizontal centrifugal pump. The deepwell turbine is required whenever the water supply level exceeds approximately fifteen feet below the pump discharge. The turbine pump has the disadvantage of having what is termed as a very steep curve, in that when the capacity drops off, the pressure goes up very rapidly, and as the capacity is increased, the pressure drops very markedly.

The centrifugal pump is best suited for sprinkler systems due to its operating characteristics. That is, that its operating curve would show as quite flat and changes in capacity do not generally make appreciable changes in discharge pressure. However, whenever the suction lift exceeds fifteen feet, it is highly recommended to change to a turbine type pump.

In closing, I would like to point out that it is essential that each turf sprinkling system be tailor-made to the area that is to be sprinkled. For those systems which are obsolete and deteriorating, it is highly possible that excessive labor and maintenance costs are equal to that which would have to be paid for a new modern system.

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## FAIRY RING DISEASE OF LAWNS

Charles J. Gould, V. L. Miller and Dorothy Polley
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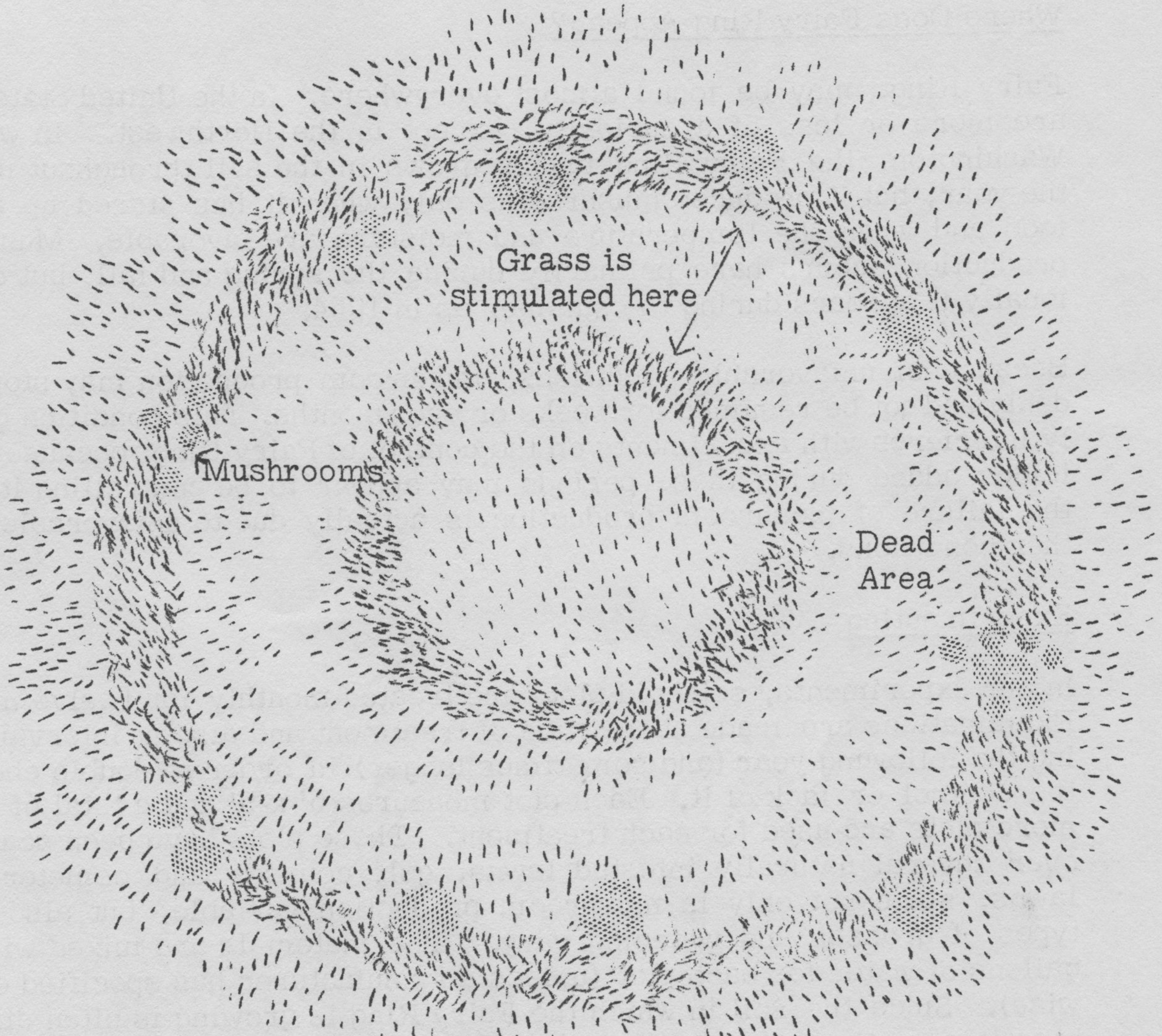
### What is Fairy Ring?

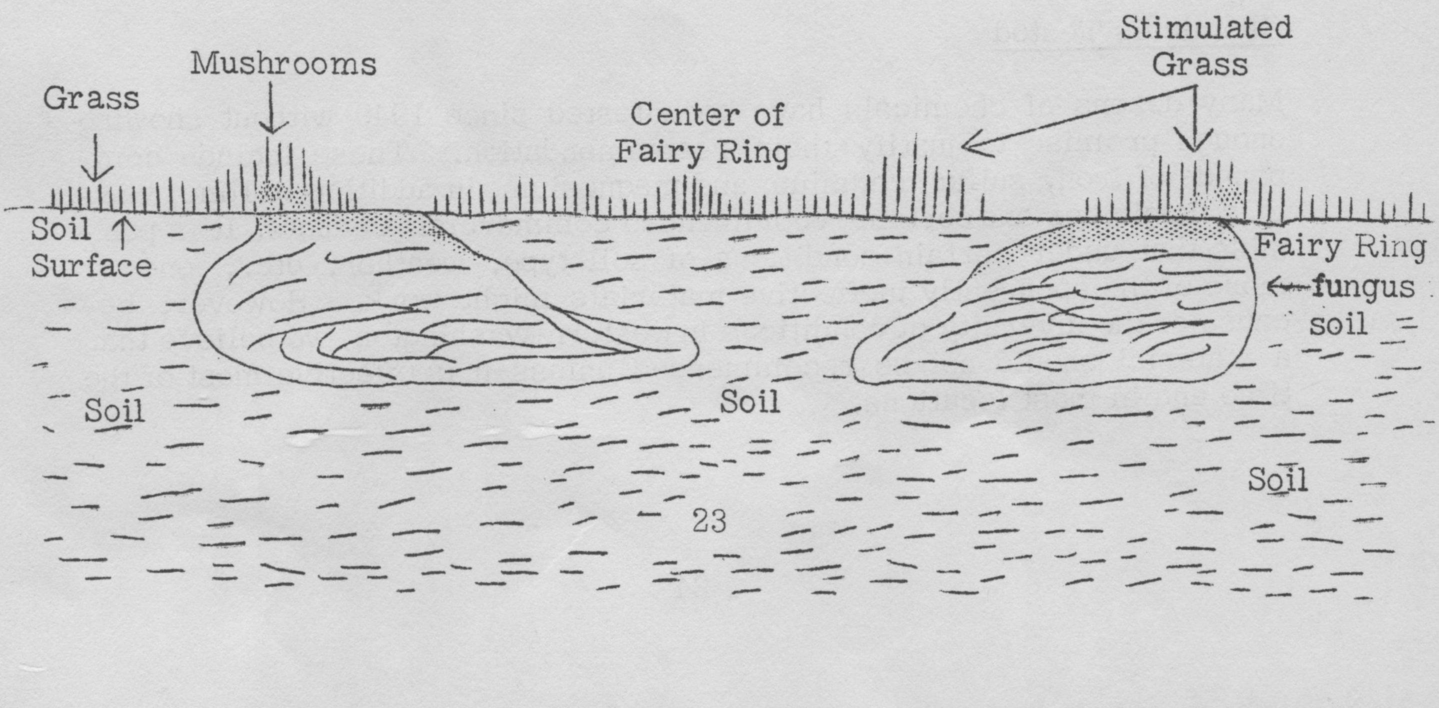
Fairy Ring is caused by a fungus or mold that lives in the soil. When it has stored up enough food; when there is enough moisture in the soil; and when the temperature is right; mushrooms (or toadstools) are formed. These produce spores which correspond to seeds of plants. The spores are blown through the air and will initiate a new Fairy Ring if they land in a suitable place.

The Fairy Ring fungus grows outward at a rate varying from a few inches to as much as two feet a year. It grows in a ring unless it meets an obstruction. Many centuries ago people thought that such rings formed where fairies had danced the night before -- hence, the name, Fairy Ring. Several different types of mushrooms and puffballs may produce Fairy Rings. The one that we see most often is small (2-3 inches high), tan in color and is known scientifically as *Marasmius oreades*.

The fungus grows throughout the soil, sometimes to a depth of 8 or more inches, but is most concentrated near the surface where it feeds upon dead grass, leaves and other organic matter. During this feeding it breaks down the organic nitrogen compounds. The resulting materials stimulate both grass and fungus growth. The fungus continues growing, using considerable moisture and nutrients, at the expense of the grass. In addition, the fungus often makes such a heavy growth in the soil that water cannot penetrate to the grass roots. Hence, the grass is weakened and may die from lack of water and food. As the fungus grows outward its older parts die and the nutrients it releases are used by grasses and weeds. Therefore we often find rings appearing as shown on Page 23.

## Outline and Cross Section of a Typical Fairy Ring



## Where Does Fairy Ring Appear?

Fairy Rings may be found almost everywhere. In the United States they are more or less of a curiosity, except in the Northwest. In western Washington, the Fairy Ring fungus grows in the soil throughout most of the year, but it produces mushrooms only when it has stored up enough food and when the temperature and moisture are favorable. Mushroom production occurs here primarily during the spring and fall, but occasionally it appears during the summer as in 1954.

Because of unfavorable conditions, mushroom production may stop suddenly and not be resumed for weeks or even months. This condition greatly interferes with experiments on the control of Fairy Rings because fungicides added during these periods may appear to be controlling it when the failure of mushroom production is actually due to unfavorable weather conditions.

## Experimenting

In our experiments, selected plots are treated monthly for twelve months. Examinations are made at the time of treatment and also at intervals during the following year (and sometimes longer) in order to double check on the control or lack of it. Each plot measures 5' x 5' and a total of ten or more plots are used for each treatment. These plots have been scattered over several naturally infested lawns, golf courses and cemeteries in lawns, since not only is mushroom production variable, but also soils, types of grasses and watering vary. The materials are mixed with two gallons of water for each plot (unless a manufacturer has specified otherwise). Since the soil in which the Fairy Ring is growing is often difficult to wet, a wetting agent (or detergent) has often been added to the solutions to help the penetration. In addition, holes are punched every three inches in the turf before starting the experiment.

## Chemicals Tested

Many dozens of chemicals have been tested since 1949 without showing enough promise to justify their recommendation. These include compounds of iron, sulfur, cadmium and magnesium, in addition to lime; various fungicides and certain recommended commercial products. It is possible that under certain conditions of soil type, weather, etc., one or more of the apparently ineffective materials might work. However, because of the diversity of conditions in western Washington, we believe that a material should not be recommended unless it is effective most of the time and in most locations.

## Tests in 1953/54

At the start of the experiments on Fairy Ring, the tests were all made on infested turf. This naturally involved considerable work and limited the number of materials that could be tested. Therefore a semi-laboratory test was developed in order to examine more compounds. To do this, boxes of compost in which the field mushroom (Agaricus compestris) was growing were treated with the various chemicals. (The assistance of the Olympic Mushroom Farms in furnishing the compost and spawn is gratefully acknowledged). Although this mushroom is not the one generally responsible for our Fairy Rings, we believed it was sufficiently similar to serve as a test organism. Out of this first set of laboratory tests a few materials emerged with promise. One of these was salicylanilide which was used in a series of field applications starting from November of 1953 to October of 1954. It has given quite promising results. Observations are continuing and if the results continue favorable, additional research will be done on it.

## Tests in 1954/55

Meanwhile in additional laboratory tests during the winter of 1953/54, two other materials appeared very promising. These were phenyl mercuric acetate (PMA) and dinitrofulorobenzene. Tests using these materials were started on five lawns (involving 105 plots) in Pierce County in June of 1954 and monthly applications continued until May of 1955. They were used at a rate of 4 and 8 pounds (active material) per acre (or approximately 1.5 and 3 ounces per 1000 square feet.) The PMA was stabilized by two different methods to keep it in solution in the soil. Triton X-100 (a wetting agent) was added to aid the solution in penetrating the soil, and the experimental area was also spiked before starting the experiment.

Results were noticeable by the end of September. The dinitrofluorobenzene appeared worthless while all of the mercury applications appeared promising. These results have been substantiated by monthly counts of mushrooms. For instance, from January 1 (1955) to September 16, only 39 mushrooms were produced in the 15 plots treated with PMA @ 4 lbs. plus Stabilizer 10 as compared to 1288 for the untreated plots. Most of the mushrooms in the PMA-treated plots, developed on two lawns that were infrequently watered during the summer. Hence, it appears that proper culture may have to accompany suitable fungicidal applications for complete control. In some instances PMA at the 4 lb. rate caused some yellowing of the grass, and on one unwatered lawn a considerable burning. Injury was severe at the 8 lb. rate.

Tests in 1955-56

These additional trials have already been started. Eleven treatments were selected, based upon the above results on lawns plus laboratory and other tests during the past winter and spring. PMA is again being tested but at a lower rate and prepared in various ways which may reduce the injury to grass. In addition, two other organic mercury preparations and one nitrobenzene compound are included. Some of these have wetting agents and some don't. Some are being applied for only 6 months and some for 12. There are a total of 144 new plots. From them we hope to find one or more treatments that can be recommended for trial by home owners in 1956.

Recommendations

The Fairy Ring mushroom is most harmful to grass that is weakened from lack of water or fertilizers. Therefore we suggest keeping lawns well-watered and well-fertilized according to directions in the Washington State College Extension Bulletin (#482) on Lawns, which may be obtained from your local county agent. We have noticed that many lawns heavily infested with mushrooms have sometimes been heavily fertilized with such organic fertilizers as chicken manure. Experiments will be made to test the effect of various lawn fertilizers on Fairy Ring in cooperation with the Agronomy Department as soon as the fungicidal treatments are perfected and time permits.

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## GOLF GREEN MAINTENANCE

Sam Zook, Golf Course Superintendent
Waverely Country Club, Oregon

I had my soil on my greens analyzed by Swift and Company to help me establish a definite fertilizer program. The pH on all greens was low 5.5 and below, so I made two applications of Dolomitic lime at 40 lbs. per 1000 square feet. I also applied iron sulphate at 1 1/2 ounces per 1000 square feet and epsom salts at 3 ounces per 1000 square feet. For a balanced fertilizer feeding I made three applications of Swifts Golden Vigoro 6-10-4 at 30 day intervals, at 300 lbs. per 1000 square feet. I also applied top dressing of soil and milorganite after each aerifying. For added nitrogen I used a number of different products. NuGreen 36% N., Urea 45% N., Amm. Nitrate 15.5% N., Sulphate of Amm. 21% N. I applied them in spray and dry form at ten day intervals throughout the growing season. I strived to get approximately 1 1/2 lbs. to 2 lbs. of ActualN. per 1000 square feet each application.

The greens are cut seven days per week at a height of 3/16 inches. Watered very sparingly. They were vertical and aerified at least 3 times during the growing season.

I also used a Haines Root Cutter to keep the tree feeder roots from coming into the greens.

For fungicides, I have stayed with Cadminate (Dollar Spot) and Calaclor for snow mold and brown patch.

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## FUNDAMENTALS OF BENTGRASS MAINTENANCE

C. G. Wilson, Agronomist
Milwaukee Sewerage Commission

Some will wonder from the title of this talk, "What about bentgrass makes it worthy of separate discussion?" or, "Why should bentgrass differ radically from other cool-season grasses in its maintenance requirements?"

To answer the first question, bentgrass might well be considered the prima donna of turf. When it is managed properly, nothing else quite compares with it from the standpoint of beauty. Its utility value also is well-known. In a golfer's mind, no finer playing turf exists. We know of one satisfactory athletic field in Mexico City that is solid Washington bentgrass, although we would be the last to recommend it for this purpose. Even in tropical climes it is receiving increasing attention as a companion crop for Bermuda during the cool season. And last, but far from least, the layman's idea of a lawn Utopia is a broad expanse of No. 18 green from the Country Club in front of his home.

These facts are self-evident. Why else would mankind fool with a turfgrass that seems to fall prey to every ill known to the plant kingdom? Actually, the bentgrasses are more sturdy than some of us are willing to believe. We have heard it said: "They certainly are not drought-tolerant.

Next to *Poa annua*, bents are the first to turn brown when water is lacking. They certainly are not disease-resistant. Name a turf disease and you will find it has been recorded as attacking bent. They certainly are not insect-resistant. If bugs could choose, bent would receive preference 10 to 1. They certainly are not heat and wear-resistant. In hot, humid areas we are even afraid to use a greens mower on them during midday".

Ah! But are we being fair to this "Prince or Pauper", or have our eyes deceived us? Bents may fall somewhat short on drought-tolerance, but their resistance or ability to recover after a dry spell is great. After a lapse of time let's take a second look at what we thought was brown, dead turf, and we may be pleasantly surprised at the recovery. The same holds true for disease. Marshall Farnham, Superintendent, Philadelphia Country Club, has no objection to light disease attacks on his bent fairways. He is probably right in giving nature credit for an assist in keeping down thatch in this manner. Insects will attack any grass. The most notorious bug problem is scale on Bermuda - not bent. Not heat-resistant? Bent probably has a greater tolerance for heat than any cool-season grass. Yuma Country Club's summer temperatures of 115 degrees Fahrenheit hasn't prevented Tige Stanley from maintaining some of the best year around bent greens in the world. As to ability to withstand punishment in both hot and cool weather, who will challenge Bill Johnson's official record average of 306 players a day for 365 days at the 18-hole Rancho Golf Course in Los Angeles?

Bent is seldom condemned from the standpoint of cold tolerance. Most winter injury relates to disease, drying out, or poor drainage. All cool-season grasses are subject to these maladies and one should never condemn bent for suffering under poor drainage because close observance will indicate that bent was the only grass capable of existing under such conditions to begin with! Bent really comes into its own in cold climates if there is a desire to lengthen the playing season by getting an earlier start in the spring. Annual blue grass may be sanctioned for resort courses with their late opening date. However, city clubs with their permanent resident members are entitled to something better than "Poa". Here again, an improved bent is the answer.

If, then, you agree that bentgrasses will be with us for many years to come, the answer to the second question concerning maintenance requirements, whether they differ radically or no, is worthy of our attention. We are all aware that a poor bent strain in the hands of a good turf manager can perform beyond our highest expectations. Conversely, the best of improved bent strains is worthless if management is bad. Therefore, it behooves one to understand the idiosyncrasies of this "prima donna" of the turf world. Quite naturally, this paper cannot delve into the basic fundamental requirements of all turfgrasses. Bent is no different from the others in being capable of responding to a deep, uniform soil profile of proper texture and structure to permit rapid removal of excess moisture yet hold a sufficient quantity to promote good growth.

Bentgrass is unique, and, some will say, finicky, in its maintenance requirements. Where lawn and garden experts are correct in advocating a high height of cut for most lawn mixtures, such practices are disastrous on bent. For lawn and fairway purposes, it should never be mowed higher than 3/4 inch, and preferably the height should be below 1/2 inch. We know of bentgrass greens that are mowed daily at 3/16 inch during the growing season, and such practices have not varied over many years.

As a matter of fact, one's mowing practices directly influence success or failure with this grass. Because of its vigor, bentgrass must be mowed frequently or partially decomposed stems, stolons and clippings will build up above the soil surface. We call this build-up "thatch" or "mat" and strongly object to it because it harbors disease organisms; both holds and sheds moisture; and is detrimental to play of the game. On putting greens this problem is even more severe because of the intensified cultural practices. A worthwhile step towards arresting thatch development is elimination of the scalping roller by substituing side caster wheels. The roller is very effective in pressing down the grass before contact is made with the bed knife and reel, and no doubt is equally effective for selling purposes in demonstrating a new machine. Where labor cannot be trained, to mow properly without a scalping roller, combs, or brushes must be used throughout much of the good growing season.

Vertical mowing machines, Delmonte rakes, combs for fairway units, and a garden rake with sharply filed teeth also have their place in keeping thatch under control. Rather than object to bent because of its thatch-producing tendency, we should be thankful that a grass with so much vigor exists, while at the same time keeping the problem under control. Remember, grass should be growing in the soil and not on top of the ground. Some will argue that a little thatch is necessary to hold the approach shot. We think this can be accomplished through proper nutrition on actively growing grass. We will agree that a sole or cushion of turf is needed, but maintain it should not be dead organic matter.

An actively growing child requires plenty of food, and unlike we older folks, utilizes it for growth rather than to add more fat. Possibly for the same reason an actively growing grass like bent has high fertility requirements. Unlike humans, grass has the ability to manufacture its own food. And, like any manufacturing plant, it must have a supply of raw materials on hand in order to accomplish this end. The building blocks for bentgrass have received a great deal of attention from turf research workers and practical superintendents in the field. As a result of all this work, we know that bent thrives best on neutral to slightly acid or slightly alkaline soil in the range of pH 6.5 to pH 7.5. Seven is the neutral point. When the scale drops below pH 6.0 it is time to add lime to correct acidity. Soil-testing service is available from most Experiment Stations, a few fertilizer companies and several laboratories.

Soil tests serve another valuable function in giving us an inventory of some of the fertilizer elements required by grass. Samples must be taken in accordance with directions, and must be properly interpreted by a person who has some knowledge of growing grass. When used in this light, soil-testing recommendations will over come deficiencies of phosphorus, potash, calcium and magnesium. After this has been done, bentgrass feeding is primarily a matter of supplying nitrogen at the right time and at the right amount.

Plant pathologists tell us that dollarspot is minimized when the grass is utilizing 1 1/2 to 2 pounds of actual nitrogen per 1,000 square feet per month during good growing weather. This rate is equivalent to 25 to 35 pounds of a natural organic source of nitrogen. Timing also enters the picture. Where summer brown patch is troublesome, rates should be lowered and fertilizer applied more frequently. The difference can be made up by applying more during the spring, early summer and fall. Where snow mold is troublesome, some say the bent should become slightly hungry for nitrogen before entering the winter season. Here again compensation is made by applying more during spring, summer, and possibly early fall. It is a simple matter for anyone to determine the length of growing season by checking with their local agricultural authorities. These general principles also hold true for other bentgrass turf areas. In recent years, research workers have indicated that even where clippings are allowed to remain, growth increments continue above one pound of actual nitrogen per 1,000 square feet per month of good growing weather even on inherent fertile soils.

Water management is very critical on bentgrass. Since bent is a shallow-rooted turf species, it must be watered at a lighter rate and more frequently than Kentucky blue grass or possibly the red fescues. A good rule-of-thumb is to add water when the grass wilts. Wilting is distinguished by an off-color gunmetal blue, lack of dew in the morning, or foot-printing. The important point to remember is that bent can wilt when temperatures are high if the above condition is noticed. Neglect of this can result in brown turf, especially on greens.

We should also add that bentgrasses are often damaged by indiscriminate use of 2,4-D and related compounds, and insecticide emulsions where a petroleum derivative is used as a vehicle to keep the ingredient in suspension. Concerning insecticides, wettable powders are far safer to use.

In weed control work, arsenicals still are unsurpassed when coupled with an adequate feeding program. It is recognized by all foremost turfgrass authorities that weeds are secondary rather than primary causes of poor turf. Without exception, they advocate that good management will either keep weeds at a minimum or enable a good herbicide to accomplish the desired control.

In conclusion, we must say a word about the bentgrass family. The title of this talk indicates that we are dealing with one grass. This is far from the case. Bents are as variable as your children and mine. We have coarse strains and fine strains; selections that are susceptible to snow mold, but resistant to brown patch; types that are grainy and types that are tight; and rugged individuals that endure drought but cannot stand wet feet - or vice versa. With such a broad genetic base, a vegetative strain to meet any need is either available or waiting for someone to select it.

Therefore, when you think of turf, be sure to include the bents in your thoughts. Good management makes them tops in their field. Why settle for less?

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## SOME PROMISING NEW HERBICIDES

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Washington State College
Northwestern Washington Experiment Station
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Each year manufacturers of agricultural chemicals test a vast number of materials for possible use as herbicides. From these screening trials of two or three years only a relatively small number show enough promise to warrant release to agricultural experiment stations for further testing under field conditions on different crops, in different soils, and in different climates. Again, many of these potential new herbicides are discarded due to insufficient phytotoxicity or lack of selectivity in killing some plant species and not others. Consequently after several seasons' trial in screening experiments only a relatively few chemicals show enough promise to be included in more detailed experiments. It is the purpose of this report to summarize briefly the potentialities of some of these more promising herbicides from this past season's trials at the Northwestern Washington Experiment Station.

1. N-methyl dithiocarbamate dihydrate ("Vapam")

A soil fumigant which has given excellent control of weed seeds under greenhouse conditions. Could also be used for temporary sterilization of new lawns, plant beds, small home gardens, etc. May be applied as a drench in water at 1 to 2 quarts per 100 square feet, followed by a thorough soaking of the treated area. Low in animal toxicity compared to other soil fumigants. Needs further testing as to its applicability on field crops.

2. 2,4,5-trichlorophenoxypropionic acid or 2,4,5-TP ("Kuron", "Propon-4", "Silvex", etc.)

This chemical is related to 2,4-D, 2,4,5,-T, MCP, etc., and exhibits the same sort of activity. However it is reported to be more effective on some brush species than 2,4,5-T, i.e. oak and red maple. Experiments on brush species (blackberry, wild rose, snowberry, etc.) common in western Washington are still in progress.

3. 3-(3,4-dichlorophenyl)-1, 1-dimethylurea or DMU ("Telvar DW")

A soil sterilant with even a longer residual activity in the soil than CMU. Applied in combination with 2,4-D at rates of 40 to 80 pounds per acre, this herbicide should keep ground devoid of almost all vegetation for two or more years. Periodic retreatment at lesser rates of application should maintain bare ground. DMU applications should be made during periods of high rainfall for best results. Precaution: Do not apply DMU near desirable shrubbery, trees or ornamentals. Plants which are a considerable distance from the location of DMU treatments may have roots which extend to the treated area. These roots will absorb DMU and will "translocate" the herbicide within the plant so that severe injury or even death may occur.

4. 2,2-dichloropropionic acid ("Dalapon")

A new plant growth regulator which is effective on grasses has been under trial for several years in many parts of the country. This herbicide has shown particular promise in pasture renovation trials. Its residual activity in the soil is short so that crop species may be planted within a relatively short time after treatment. Since complete kill of all underground parts is not obtained even with Dalapon, and since the vigor of weedy perennial grasses is high, chemical treatment should be combined with cultivation to obtain control of perennial grasses.

5. 3-amino-1,2,4-triazole or amino triazole ("Amizol", "Weedazol")

Another systemic grass killer which also has proven effective on certain perennial broadleaved weeds such as Canada thistle and poison ivy. With this herbicide as with Dalapon chemical treatment should be followed by plowing or heavy discing one or two weeks after application. Best results will be obtained when amino triazole is sprayed on vigorous, rapidly growing plants in the early spring. Residual activity of this chemical is very short, so that in a matter of weeks a crop can be planted in ground that has received amino triazole treatment.

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## THE MOLE AND I

Milt Bauman, Golf Course Superintendent,
Overlake Golf Club, Medina, Washington

The main topic of my talk will pertain to moles. The mole is a fur bearing and burrowing animal. The mature mole is about six inches long and three inches high. It has hind legs like a rat but the front paws are very large and shaped like hands. These paws are attached to the body by very short legs and the paws are the tools which do the digging. The nose or snout of the mole is long and slender and resembles the ant eater in appearance. The mole has no eyes and his diet is earthworms or angleworms.

The runway of the mole is generally about eighteen inches below the ground-surface and occasionally may be as deep as four feet. From these main runways, they move out and burrow just under the surface for their food. Sometimes at night they will feed on top of the ground. At times, the grass is injured where moles are working and the mole gets the credit for the damage to the grass roots when in all probability the field mouse has made his home in the moles' burrow and he is the culprit who eats the grass roots.

There are several ways to get rid of the mole. I prefer the trap. When you catch them in a trap, you are sure you have them. When you use different types of gas, you are never quite sure. There are several types of traps and I am confident they will all work but the one I am most familiar with and have had good success is the type which has two large jaws and a large spring with the trigger paddle between. The trap is placed in the runway with the bottom of the jaws a triffle lower than the bottom of the runway. Loose earth is then put all through and over the trap. The mole comes through his runway, passes between the trap jaws and bumps the paddle or trigger and the spring is released which closes the jaws on the mole. Of utmost importance is the sterilization of the trap. The mole has no eyes and his nose is his lifeline and there cannot be any scent on a mole trap and still have success at trapping them. Leave the mole trap out in the weather and use an old pair of gloves when setting the trap.

I have also had fair to good success in using regular commercial mole bombs. I have found that in the winter when the moles are on high ground surrounded by water, the use of bombs are quite successful. A bomb dropped in a fresh runway will chase a mole away and it will not return for a long period of time. When I find a mole working too close to a green or tee I drop in a bomb and chase it away.

I have also had fair success with mehyl bromide gas, the application and gas being very simple and easy to use. It is a deadly gas with no odor and will lay in the runways for several days. Cyno gas is also used with a reasonable amount of success. There are also mole pellets on the market that are supposed to be very good. I have had no experience with the pellets.

Some superintendents stuff a high pressure water hose down the runway of the mole and wash him out. Also, a hose attached to the exhaust pipe of a car or tractor has been used with fair results.

The mole is a persistant, hard to catch, hard to kill, turf abusing rodent that will be with us for quite awhile.

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# THE MERION PICTURE

J. L. Chapman, Jacklin Seed Company
Dishman, Washington

Seed supplies of Merion is still short in the face of a rapidly expanding acreage for seed production. 1955 production may total about 900,000 pounds compared to about 850,000 in 1954. Acreage for seed production in 1955 was at least 1/3 larger than 1954. This illustrates a major problem with Merion and that is the difficulties encountered in seed production.

Production per acre is erratic at best and all of the factors influencing production have not been determined.

The supplies on hand would indicate the price will not be greatly different from 1954. It is difficult to see much of a price reduction in Merion seed for next year.

In using Merion in mixtures we prefer to use not less than 40% Merion by weight. Merion-creeping red mixtures look good in the Spokane area. They offer better initial cover during the year of establishment and Merion largely replaces the other grass in a few years.

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# SOME PRACTICAL ASPECTS OF SOIL MANAGEMENT

Dr. Fred V. Grau, Agronomist
West Point Products Corporation, West Point, Pa.

Soil management is basic to growing good grass on athletic fields, golf courses, lawns or any other turfgrass areas.

Soils become crusted, hard and compact under constant trampling by men and machines. The soil that is used and abused becomes dead -- lifeless devoid of life-giving oxygen and incapable of releasing nutrients that support life. Compact soils shed water, let lime and fertilizer and seed lie on top of the hard ground where it will be washed or blown away or otherwise wasted. Compact soils cause excessive injuries to players which largely can be avoided by proper soil management.

Good soil structure is represented by friable, granular porous soil into which water can rapidly soak and in which grass roots can expand freely. This is the condition which produces resilient, springy turf that cushions the players' falls and absorbs the shocks, greatly adding to the safety factor on athletic fields. This is the soil that makes fairways soft and easy to walk upon; makes putting greens resilient enough to hold the ball even when the soil is dry. This is the condition that Nature provided in our great grassland soils of the midwest before man started modifying these wonderful soils for his own purposes. These great soils had the soil particles grouped into clusters or granules, held in place by the dynamic organic matter developed from the grass roots. This was the ideal condition.

Under the constant pounding of foot and machinery traffic, in fair weather and foul, wet or dry, these lovely soil granules gradually disintegrated and broke down into individual soil particles which got squeezed together more and more. Finally, our once-porous soil became a sticky, gummy mass of clay particles, lubricated by excessive water, compacted to the point where neither air, nor fertilizer, nor water, nor roots could penetrate. At this point the weeds take over because most turfgrasses cannot grow under these conditions.

Nature tries to correct man's mistakes by sending the frost to dry the soil and to loosen it so the grass can grow again. Unfortunately, freezing and thawing lasts only a short time in fall and in spring and the benefits are soon gone. The greatest factors in producing good structure in soils are <u>wetting</u> and <u>drying</u>. This has been going on since the beginning of the Earth. When a soil is wetted it expands. When it dries it shrinks and cracks. These cracks let air into the soil. Roots can grow into the cracks and water and nutrients can move freely. Freezing actually is a drying process and thawing is a wetting process. The important thing to remember is that wetting and drying will help us build good structure in our turfgrass soils.

Farmers plow and disc and harrow and cultivate their soils to rebuild good structure and to grow good crops. It isn't accepted practice to plow an athletic field or a golf course each time the compacted soil needs cultivation. But we do have aerifying equipment which was designed and built to cultivate the soil under turf. Aerifying compacted soils on athletic fields and golf courses is just as basic to growing good grass as plowing and cultivating is to a farmer's crop.

The farmer gets rid of organic residues -- trash -- by mixing it withsoil and supplying nitrogen to assist the micro-organisms to break it down into useful humus. The turfgrass superintendent can do this by aerifying, still keeping the turf in play, reducing thatch and mat (organic residues or trash) by mixing them with soil, supplying nutrients to aid the soil organisms.

The process of frequently aerifying turfgrass areas assists in building good soil structure by bringing soil to the surface to dry. The soil cores scooped out by the Aerifier spoons are left on the surface to dry and crumble. The cavities in the soil admit water, air, fertilizer and lime and give grass roots a chance to grow. Then, by crumbling and dragging the turf with a dragmat, the well-aerated soil acts as a gentle topdressing which smooths and levels the surface for better play and for smoother mower operation. Seed, when needed, finds lodging in the holes left by aerifying and is given the best possible chance to grow and produce useable turf. Most seed that is sown on a crusted surface germinates and dies because the roots cannot get through the compact layer in the surface.

On athletic fields the immediate effect of aerifying is to develop a softer, more resilient surface that reduces injuries as a result of bodily contact with the soil. Race horse breeders in Kentucky have learned that the Aerifier used frequently on their bluegrass pastures is a good thing for their horses feet. If it is good for a race horse it is good for an athlete or a golfer walking over acres of fairways.

Trampling on a wet bluegrass turf can result in immediate compaction, to the extent that 88% of a rain will run off, not able to soak into the soil. The same bluegrass turf, adequately aerified, will absorb all of the rainfall.

Dr. Harper's work at Penn State showed that aerifying resulted in nearly 60% more phosphate reaching the 4 to 6 inch level in the rootzone six weeks after double aerifying. The effect at that time was to increase the measurable root growth by 7.7%. Roots are so very important in building good soil and good safe turf that these studies become highly significant.

Alderfer, formerly at Penn State, now head of the Soils Department at Rutgers University, shows us that a sandy soil is no proof against compaction. A compacted sandy soil causes runoff to the same degree as a compacted clay loam soil. Aerifying is effective on all types of soils.

Coming right down to the practical aspects, I would like to mention a few technic in aerifying. "Multiple aerifying" is the new method that is being tried out on putting greens with very satisfactory results. Everyone who has used the Aerifier has seen the bright green color of the grass surrounding each opening made by the spoons. The beneficial stimulation to the grass is clearly evident. When a green is aerified just one time, grass is stimulated in the separate spots where each spoon has cultivated. By "multiple aerifying" -- that is passing the Aerifier over the area FOUR times, each time in a different direction -- stimulation of the grass is uniform. Better color and increased resilience are to be found over the entire area. This method was used at Beechmont Country Club in Ohio on all 18 greens. As a result they were able for the first time to hold grass throughout the playing season, and at the end of August the bent roots were down 4 or 5 inches.

Naturally, "multiple aerifying" is not going to be carried out every month. It should be done in the spring and in the fall, while grass is growing actively and play is not at its peak. Developing deep, vigorous root systems during the periods which are favorable to growth produces a turf that will stand up through adverse summer weather and heavy use.

Important as the soil management is the selection of adapted grasses. In the south bermudagrass is the No. 1 grass for athletic fields, playgrounds and golf courses.

In the Midwest and in the North, we place our dependence on fescues, bluegrasses and bents. A combination of tall fescue and bluegrass produces highly desirable sports turf. Alta and Kentucky 31 are two types of tall fescue. Both are deep-rooted, sturdy and drought-resistant. Kentucky 31 tends to have leaves that are slightly narrower than Alta and may have slightly greater tolerance to diseases.

Kentucky bluegrass is well-adapted for hard wear, for good healing and for beauty on athletic fields and fairways. Merion bluegrass is an improved variety which has greater resistance to leafspot but is more susceptible to rust late in the summer. Merion stands closer mowing and has a heavier system of roots and rhizomes.

For putting greens we have improved bents and improved bermudas. In the south improved bermudas provide the fine texture that is desirable in putting green turf. Vigor and disease resistance are found in the improved bentgrasses. Pennlu is an outstanding new creeping bent that scored high in every quality factor in tests at Penn State. It is vigorous, disease-resistant and of good color and density. Pennlu is showing up well in many locations throughout the country.

A sod of any of these grasses responds best to a program of frequent aerifying, generous fertilization, water as needed to replenish the soil moisture to a depth of several feet and frequent mowing at the correct height.

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## CHANGING YOUR SOIL

J. R. Watson, Jr., Chief Agronomist,
Toro Manufacturing Company, Minneapolis, Minnesota

Desirable turfgrass growth in a given location is a function of the climatic conditions, soil properties and management practices prevailing.

Climate exerts its influence through temperature, rainfall, wind movement and sunlight. Climate is of particular importance in determining the choice of an individual species or strain of a warm or cool season turfgrass for a particular use is predicated on its adapation to climatic conditions.

Soil properties influence the kind and quality of turfgrass in a number of ways. There are certain basic requirements which soil must provide for satisfactory turfgrass growth. These are: support, water, air (oxygen), temperature and nutrients. The ability of a soil to meet these requirements is dependent upon its physical, chemical and biological properties.

Management embodies the choice of grass, watering, fertilizing, aerating and mowing practices, choice and application of various chemicals and all other areas of turfgrass care and management requiring decisions by the supervisor. The most important part of management is actually the first three letters of the word, <u>M A N</u>. The good manager may be able to produce satisfactory turfgrass in spite of unfavorable conditions, but the poor manager will have difficulty producing satisfactory turfgrass under the most favorable conditions.

The discussion today is to deal with only one of the many problems confronting the supervisor charged with developing and maintaining satisfactory turfgrass. Man has little control over climatic conditions and actually rather limited choice in the type of turfgrass he may select for a given set of use conditions in a particular locality. It is through modification of the soil that the greatest opportunity for adjustment to climatic and use conditions exist.

If any soil physical, chemical or biological factor or factors are or will limit satisfactory turfgrass growth, it may be necessary to correct or prevent this situation by modification or adjustment. The title of our discussion, "Doctoring Your Soil" implies that changing or altering (modification) of soil factors limiting turfgrass growth may, if performed incorrectly, give rise to an even more serious situation. That such may be the case is, unforturately, true. In this discussion we will attempt to point out some of the "whys" and "wherefores" and to emphasize some of the pitfalls associated with modification.

The stage for this discussion may well be set by asking a series of questions. Is soil modification necessary? Is it practical and economical? If the answers to these questions are "yes", then, which soil properties lend themselves to adjustment and modification? If modification is undertaken, how must it be approached? Is there danger in soil modification? In order to answer these questions, it may be well to define some of the fundamental relationships between various soil properties and turfgrass growth. Accordingly, let us briefly review some of the basic concepts associated with soil properties and plant growth.

## Classification of Soil Properties

Soil properties are classified as physical, chemical and biological. Each of these groups exert certain direct and indirect effects upon the soil mass and the plants growing therein. There is also a marked inter-relationship between the three groups of properties. The physical phenomena have important effects on the chemical and biological properties and processes which in turf, influence plant growth. Biological properties play a vital role in promoting favorable environment through their effect on the physical and chemical factors. So likewise are the chemical properties influenced by the physical and biological properties. It is apparent, then, that modification of any physical, chemical or biological soil property will affect directly or indirectly all other soil properties which, in turn, influences turfgrass growth.

## Chemical Properties of Soil

Chemical properties of soils include the reaction (pH) and the fertility relationships. Modification by the application of lime, gypsum, sulfur and the addition of nutrients (in the form of fertilizer) is a common practice. In most cases these practices are necessary, practical and economical. In some cases thay may be dangerour. The danger lies in applying either insufficient or excessive amounts of any particular material. Modification of chemical properties may also be dangerous if the improper material is selected, or if it is applied incorrectly or at the wrong time. For example, the addition of lime to a soil with a high pH may result in a further tie-up of certain nutrients -- iron. Excessive applications ofphosphorus to a soil already high in this element could upset the nutrient balance between nitrogen, phosphorus and potash and stimulate the growth of certain weeds at the expense of the turfgrass. Inadequate or excessive applications of nitrogen may not only upset the nutrient balance, but also intensify a number of problems such as disease incidence, insect infestation, winter kill, etc.

The answers to our original questions, when applied to chemical soil properties, are simply "yes", modification is feasible, practical and in fact necessary more often than not". It is dangerous only when performed improperly -- too little or too much of the right or wrong material at the wrong time.

## Biological Properties of Soils

Biological soil properties include the micro and macro-plant and animal populations of the soil. The populations of these plants and animals may be beneficial or harmful. They are so markedly influenced by physical and chemical soil properties (and vice versa) that no effort will be made to discuss modification of this particular group of soil properties. It should perhaps be noted, however, that the harmful populations, such as certain disease organisms, weeds and insects must be checked by the application of the appropriate fungicide, herbicide or insecticide. Fortunately, most of the micro and macro-populations of soil organisms are beneficial.

## Physical Properties of Soils

The physical properties of the soil (texture, structure, porosity, etc.) govern the infiltration, retention and movement of moisture in the soil medium, controls the air-water relationships and, along with the chemical and biological properties, determines the type of turfgrass that grows best under a given set of climatic conditions. This group of factors deserves, perhaps, the most serious attention in a consideration of soil modification. Each of the physical soil properties exerts a direct affect on plant growth and each is dependent, one on the other, for the ultimate effects they produce on other soil properties and on turfgrass growth. This close degree of inter-relationship makes discussion without repetition practically impossible. A very brief discussion of some of the more important physical properties follows:

Organic Matter

Although comprising only a small percentage of the total soil volume, organic matter is perhaps the most important component of soils. It plays a vital and significant role in all physical, chemical and biological soil properties and functions. The original source of organic matter is plant and animal tissue, the latter contribution being far less than the former. The presence of colloidal organic matter in soils is a sign that biochemical activities are supplementing and augmenting those of a purely chemical and physical nature. Organic matter in soil serves as a constant source of plant food, especially nitrogen and sulfur; it serves as food (energy) for micro-organisms. It improves the structural relationships, thereby promoting desirable water holding capacity and aeration.

Soil Texture

Soil texture is a term used in reference to the size of the individual soil particles. It refers particularly to the proportions of sand, silt and clay in a given soil. "Soil class" terms like silt loam, clay loam, fine sandy loam, etc. indicate the predominance of the three soil separates. Texture is a most important characteristic of soils because it describes, in part, the physical qualities of soils with respect to porosity, coarseness or fineness of the soil, soil aeration, speed of water movement in the soil, moisture storage capacity and in a general way, the inherent fertility of the soil. Sandy soils are often loose, porous, droughty and low in fertility, whereas clay soils may be hard when dry or plastic when wet, poorly aerated, but possibly high in fertility. Between these two extremes we find the silt loam, loams and fine sandy loams, the ideal soil classes that are generally most desirable for plant growth.

Soil Structure

The term, "soil structure", refers to the arrangement of grouping of the individual particles into units. A structural unit maybe defined as a group or groups of particles bound together in such a manner that they exhibit different physical properties from a corresponding mass of the individual particles. Such a structural unit is called an aggregate. Terms used to describe various types of structure are granular, crumb, platy, etc. In general, the granular and crumb structure is most desirable from the standpoint of plant growth. Platy structure is generally associated with slowly permeable soils derived from shales. Soils in which structure has been destroyed -- partially or completely -- are said to be dense and compacted.

The structural aggregation of soil is greatly influenced by the amount of organic matter present. The end product of decay of organic matter -- humus -- is an integral part of soil aggregates. Sometimes it is referred to as the cementing or binding agent in aggregates. Stability of aggregates is directly dependent upon the amount of organic matter present. The recent development of synthetic soil conditioners offers, possibly, another approach to aggregate stability. It is known that these materials, properly applied, create water stable aggregates; however, the stability of these aggregates under player and equipment traffic is not known and needs further investigation.

The structural aggregation of soil determines, to a large extent, the porsity, permeability and water holding capacity of soils.

Porosity

Soil porosity may be defined as the percentage of the soil volume not occupied by solid particles. In a soil containing no moisture, the pore space will be filled with air. In a moist soil, the pores are filled with both water and air, while in a saturated soil the pores are completely filled with water. The relative amounts of water and air present will depend largely upon the size of the pores.

Two types of porosity are recognized -- textural porosity and structural porosity. Textural porosity is that associated with texture. It is the type found in water deposited sands where the individual particles are so large that no matter what is done (within limits) there still remains a certain amount of large pores. This is not necessarily true with wind blown sands which will pack or compact very tightly because of their angularity. Structural porosity is the porosity associated with the clay fraction of the soil. It is the porosity found within the aggregate.

Pores in the soil may be either capillary (small-structural porosity) or non-capillary (large-textural porosity). The large pores are responsible for drainage, whereas the small pores are responsible for moisture storage. The total amount of pore space in a soil is set by the texture. If a soil contains a certain proportion of sand, silt and clay, this sets the total amount of porosity in the soil. To a large extent, nothing in the way of management has very much effect on the total pore space, but management may have a profound effect on the proportions of small and large pores.

Actually the total porosity of a soil is not as important as the relative distribution of the pore sizes. Total porosity is inversely related to the size of the particles and increases with their irregularity of form. Porosity also varies directly with the amount of organic matter present in the soil under field conditions. The total pore space is seldom less than 30 percent (coarse, clean sand has about this amount of pore space). In silt loams the total pore space is about 50 percent. The ideal soil for plant growth would have about 50 percent total porosity equally divided between small and large pores, or in other words, contain 50 percent solids, 25 percent water space and 25 percent air space. If a soil with this type of pore space could be prepared and if one could be assured that the structural conditions could be maintained, many of our current problems on turfgrass areas would be solved. Mixing, or developing through modification, a soil with desirable physical properties is not in itself too difficult a task. The maintenance of these desirable properties is a big problem.

Modification of Physical Properties

As states earlier, physical soil properties (texture, structure, porosity, etc.) govern the infiltration, retention and movement of moisture in the soil, control the air-water relationships and, because of their inter-relationship with the chemical and biological properties, exert a major influence on the productivity of soils.

It is apparent, then, that physical soil properties are modified primarily to: (1) Improve water infiltration (getting water into the soil), (2) Improve water retention (water holding capacity -- hold some water in the soil for use by plants), (3) Facilitate percolation (movement of water through the soil column), and (4) Facilitate drainage (getting rid of the excess). When these functions proceed in a desirable manner, the air-water relationships (a fifth reason for modification) are properly balanced.

## Modification to Improve Water Infiltration

Modification to improve water infiltration becomes necessary when the soil does not take in sufficient water to meet the requirements of the turfgrass growing therein. If surface compaction is preventing water infiltration, the situation may be corrected by cultivation with existing aerating equipment. This is in general the most practical and economical solution. On newly seeded areas that have crusted, the use of a spike disc will often correct the situation. If infiltration is reduced because of an inherent textural or structural problem, modification -- as discussed later -- may be the answer on small intensively used areas; on large areas improvement through fertilization may be the only practical approach.

## Modification to Improve Porosity

The improvement of porosity (pore space) will result in improvement of water retention, percolation and air-water relationships. The addition of sharp sand, organic matter and sometimes clay or clay loam, as well as other conditioning materials, is sometimes necessary. The addition of these materials is usually economical and practical on intensive areas such as golf greens. On large scale areas, however, modification by these methods is not practical and, again, one must work with the existing soil and improve it through, primarily, fertilization and sometimes cultivation (aeration). Through these latter methods, better turfgrass cover may be developed and, hence, improvement of physical properties will result because of the beneficial effects of the grass roots themselves. In genreal, grass roots are the most effective way to improve soil structural conditions. Sometimes grass roots do not produce improved structure, but this is a result of extenuating circumstances such as compaction, excessive use of chemicals, etc.

## Modification to Improve Drainage

Two types of drainage are recognized -- surface and sub-surface. Drainage problems arise when water accumulates faster than the soil can remove it. Obviously surface drainage is of prime importance when abnormally heavy rainfall occurs. Sub-surface drainage problems are intensified by inadequate surface drainage. Sub-surface drainage becomes a problem when adequate large pores are not present, or if layers of impervious material are present in the soil profile. Modification by grading to improve surface drainage and by altering pore space, the use of tile, french drains, etc. for improving sub-surface drainage is often necessary. The topography, soil and usage will be the determining factors insofar as prevention and correction of drainage problems is concerned.

## Dangers of Modification to Improve Physical Soil Properties

Textural porosity may be modified by the addition of coarse sand, structural porosity, indirectly by the addition of clay and organic matter. We have pointed out earlier that a small pore holds water more tightly than a large pore. Water moves through soil because (1) pull or force exerted by gravity, (2) attraction of water molecules for each other which creates a tension or pull on the water -- film adjustment. For these reasons, water moves from a fine soil (small pores) to a coarse soil (large pores) only with difficulty. This may be demonstrated with columns of loam soil with and without a coarse sand layer. Equal amounts of water may be added to each column at exactly the same time. The column containing the sand will be wet throughout. The water cannot move into the sand because the small pores of the loam have a much greater attraction for the water than the large pores of the soil. If water were added to the column containing the sand layer until the loam became saturated, the excess will practically drip into the sand and then move very readily; however, the soil above the sand would remain very wet until evaporation or transpiration (loss of water from plants) removed the water. It could never be dried by drainage. If the soil in these columns were wetted from the bottom instead of the top, the loam column would be wetted, while the layered column would not. The large pores in the sand do not have sufficient attraction for water to hold it at a height to permit the loam layer to be wet.

The above describes why a golf green or any other turfgrass area should not be layered. It doesn't have to be a sand layer to be undesirable. A clay, gravel or organic layer would be as bad or worse. The greater the difference in particle size (pore size) the more aggravated the situation would be.

Layering, therefore, constitutes one of the major dangers of modification. Uniform mixing of any material used to modify soil is essential. Even organic matter must be integrated and thoroughly mixed with the existing soil if it is to perform its function of stabilizing aggregation.

If improvement by the incorporation of coarse sand is attempted, it must be remembered that large quantities will be necessary to alter effectively the texture of the soil. The exact amount to use will depend on the existing soil. As a general statement, unless one is prepared to add large amounts of sand (hence, invite the difficulties associated with this textural class -- necessity for frequent, light applications of fertilizer and frequent watering), it would be best not to add any sand.

## SUMMARY

In summary, soil modification is often necessary, practical and economical. Modification of chemical properties is generally desirable on all types of turfgrass areas. This is accomplished by adding nutrients (fertilizer) and, where needed, amendments such as lime, gypsum, etc. Modification of physical properties is practical and necessary on intensively used areas such as golf greens, some lawns and some tees. Direct modification of physical properties is not practical and economical on large scale areas and one must work with the existing soil. These areas may be modified indirectly through the use of cultivating (aerating) equipment and fertilizer.

The dangers of modification may be found in improper techniques -- too little or too much of the right or wrong material at the wrong time or in the wrong way -- the MAN part of management.

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## PROGRESS REPORT ON TURF WORK AT WESTERN WASHINGTON EXPERIMENT STATION

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### Pearlwort Control

In 1951 a 4000 sq. ft. green was established at the Western Washington Experiment Station for a study of the control of pearlwort, *Sagina procumbens*. In the spring of 1952, plots were staked out in this green to allow 11 different treatments in 4 replications. Thirty plugs of pearlwort were placed in each plot so that a uniform infestation of the weed was obtained at the outset of the experiment. Treatments applied included chlordane, sodium arsenite, 2,4-D and ammonium nitrate fertilizer in various combinations.

At the end of the second year of treatments, 1953, Dr. Peterson reported "the information that has been obtained thus far strongly recommends the use of sodium arsenite (1/2 oz. per 1000 sq. ft.) applied in a dry mix with a supplemental fertilizer. The importance of the supplemental fertilizer cannot be overemphasized".

In the fall of 1954 - after three years of treatments - the original thirty plugs of pearlwort are almost entirely eliminated from all plots and have been replaced by grass. New patches of the weed have shown up, but they are not so large or numerous as to be seriously objectionable. It would appear that something in the management of this green for these three years has produced an environment unfavorable to the growth and spread of the pearlwort plant. Two factors which may be wholly or partly responsible are (1) liberal fertilization, which promotes vigorous, competitive grass growth, and (2) control of the seed source by complete removal away from the green of all clippings. Under these conditions also, no seed was brought in from fairways by machinery, golfers or other means.

## Soil Conditioners

In the spring of 1954 an experiment was set up, with the cooperation of the Monsanto Chemical Company, to study the effect of soil conditioners on the establishment and quality of greens. Three soils were used, (1) the native, impervious clay occurring on the Station campus, (2) a mixture of sawdust, sand, topsoil, and native clay and (3) a mixture similar to (2) except that peatmoss was substituted for sawdust. To each of these soils Krilium was applied at rates of 0, 2, and 3 lbs. per 100 sq. ft., and worked into the surface 6 inches.

To date, three months after seeding, the grass on the Krilium-treated clay soil is more uniform and vigorous in appearance than the grass on the untreated area. There has been no obvious difference so far between the treated and untreated areas on the mixed soils.

Records have been kept of the cost of preparing these greens and appear in Table I.

Table 1. Cost of preparing soil mixtures for 1800 sq. ft. of green to a depth of 12 inches

| Peat Mixture | | | Sawdust Mixture | | |
|---|---|---|---|---|---|
| **Materials** | | | | | |
| Topsoil | 20 yds. @ 1.40 | $28.00 | Topsoil | 20 yds. @ 1.40 | $ 28.00 |
| Sand | 15 yds. @ 2.50 | 37.50 | Sand | 15 yds. @ 2.50 | 37.50 |
| Peat | 15 bal. @ 2.55 | 38.25 | Sawdust | 20 yds. @ .77 1/4 | 15.45 |
| | | | Nitraprills 24# | @0.05 | 1.20 |
| | | $103.75 | | | $82.15 |
| **Machinery** | | | | | |
| Bulldozer 4 hrs. @ 10.00 | | 40.00 | Bulldozer | | 40.00 |
| Ferguson with scoop 9 hrs. @ 4.00 | | 36.00 | (scoop) | | 36.00 |
| Total for Machinery | | $76.00 | | | $76.00 |
| Grand Totals | | $179.75 | | | $158.15 |
| Cost per 100 sq. ft. | | $ 9.99 | | | $8.79 |

The cost of incorporating Krilium was $0.60 per 100 sq. ft. for labor and rototiller. This allowed $2.00 per hour for labor and $8.00 per day for machine rental. Ground was rototilled at 500 sq. ft. per hour. The cost of the soil conditioner at 2 lbs. per 100 sq. ft. is $3.60 and at 3 lbs. per 100 sq. ft. is $5.40.

How these three soils - with the three levels of soil conditioner - compare as greens soils will have to be decided after some years of testing.

## Turf Grass Observation Plantings

During the summer of 1954 single plots of 28 grasses and mixtures of grasses were seeded. In addition to these, 10 plots of commercial lawn mixes were seeded. Grasses seeded are:

- Seaside bentgrass
- Astoria bentgrass
- Colonial bentgrass
- Highland bentgrass
- Kentucky bluegrass
- Merion bluegrass
- Rough bluegrass
- Chewings fescue
- Illahee Red Fescue
- Rainier Red fescue
- Creeping Red fescue
- Alta fescue

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## MANAGEMENT PRACTICES, FERTILIZATION AND TURF DISEASES

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Any discussion dealing with turf diseases must be directed toward golf courses with most emphasis on greens. Turf diseases are a major problem with them.

In lawn grass maintenance diseases are seldom serious. During bad winters snow mold is not uncommon, but serious loss of grass seldom occurs. St. Augustinegrass, Zoysia to a lesser extent, and Kentucky bluegrass in parts of the West are attacked by a disease which looks like brown patch. The spots are alike except for the absence of the smoky ring because cool weather does not produce wilting of the grass along the outside edges where the organism is active. Despite the similarity in appearance, it is unlikely that the casual organisms are the same. The leaf spot diseases are widespread and may seriously damage the bentgrasses, Kentucky bluegrass and fescue. Merion bluegrass is resistant to leaf spot, but it is attacked by rust. Management factors help keep it in check, and play a part in preventing serious turf loss with other diseases. Fungicides are rarely used by the homeowners, probably because damage is seldom severe and grass recovers by itself.

In order to minimize disease, the homeowner must depend upon good maintenance practices for the particular kind of grass and the locality. By doing that, disease troubles are seldom serious. Lime should be used on moderate to strongly acid soil. After providing for phosphorus and potash, if either or both are needed, the problem is one of nitrogen feeding. Modern practice is to use some in spring, in early summer, and again in early fall. Where snow mold is a possibility, fall applications of nitrogen should be made early and the rate should be moderate so grass can harden-off before the onset of winter.

The infectious diseases of humans are caused by bacteria. Fungi are responsible for the common parasitic grass diseases. The parasitic fungi depend upon living tissue for their livelihood. They are the organisms which cause dollar spot, brown patch, snow mold, pink patch, pythium, copper spot, leaf spot, rust, etc.

Other saprophytic fungi live upon dead organic matter. The fairy ring fungus is in this class. It does not attack grass, but competes with it for the soil supply of nitrogen and moisture. Its long range control depends upon depleting the soil of cellulose material, grass stems, leaves, etc. This is accomplished by the use of a little lime and insuring a supply of air in the soil.

There are functional disorders, such as iron chlorosis which is becoming more common. Chlorosis is associated with over-wetness and high content of organic matter in the humid parts of the country. An over-abundance of phosphorus in the soil is an aggravating factor. In the semi-arid regions iron chlorosis is referred to as calcium induced chlorosis because the high pH and presence of carbonates immobilizes the iron in the soil. Over-doing lime in humid regions has the same effect. The tissues of chlorotic grass are soft and tender. They are ready prey for the organisms which cause leaf spot and every other fungal disease.

Fungicides are useful and necessary tools in the maintenance of golf greens. One shudders to contemplate as to what could happen without them. The toll of grass-less greens would be appalling in a bad year.

A fungicide which has been consistently good in controlled tests does not necessarily receive the same acclaim in practice. It is praised by some and condemned by others - unjustly sometimes. The kind of grass or the management program may be such that nothing will stop or prevent damage from disease. These factors are overlooked in most discussions about diseases and their control. Maintenance can degrade as well as improve a grass.

One course may be plagued with disease and unable to secure control with any fungicide. The course across the road has little or no disease and gets good control with the same fungicides. The soil, the grass, and the climate are identical so the difference is one of Management - with the emphasis on the MAN part.

Many years ago a Missouri club spent about five thousand dollars for fungicide and tried every known kind in a frantic attempt to save the greens. They failed dismally. Every Monday the greens received ammonium sulfate at 5 pounds per 1,000 square feet in a vain attempt to control weeds by making the soil more acid. This was during the "Acid Era" in turf maintenance. The heavy sulfating made the grass so lush that it fell prey to every known disease and possibly to unknown ones. After the grass died weeds were worse than ever. A sensible feeding program was devised and used the year following. Fungicides performed as expected and the cost for the seasonal fungicide requirements dropped from astronomical to reasonable figures.

Grass and people are alike in one respect at least. A person in a run-down or unhealthy condition invites disease. The same thing is true of grass. By skill-full management an inferior grass may look like the best. An unsound maintenance program may make a superior grass resemble the poorest strain.

At about the time the acid theory was falling into disfavor, Mr. Joe Valentine used the nursery at Merion Golf Club as a testing ground. He applied lime on a portion of the Washington bent plot. Dollar spot struck three weeks later. There was none on the limed portion. Damage was very severe on the unlimed part. In this instance lime was the thing needed to make the grass more robust so it could resist the disease.

When Victor Larson was in charge at Minneapolis Golf Club he had no end of trouble with dollar spot on his Washington bent green. There would be a bad outbreak every three weeks. Routine practice was to apply Calo-Clor to check the disease and some ammonium sulfate to speed recovery. Soil tests disclosed nothing unusual. The answer was simple but did not come until after Victor's death. We now know that dollar spot is aggravated by too little as well as too much nitrogen. A change in the fertilizer program to insure a continuous and and more uniform supply of nitrogen would have lessened dollar spot, saved fungicide, and eliminated Larson's summertime misery.

In May, 1953 leaf spot played havoc with the grass on all the greens at a prominent Buffalo club. Damage occurred in a matter of hours. Leaf spot was the immediate but not the basic cause of injury. This fact was substantiated by the failure of two of the better known leaf spot fungicides to do any good. The grass was mostly Virginia bent and *Poa annua*. The turf was badly matted, the soil was strongly acid from the continuous use of ammonium sulfate. Greens were low in magnesium and in potassium. By changing the management program, greens staged a quick comeback and were good all that year and again in 1954.

The greens were aerified and the mat was gradually removed. Dolomitic limestone was applied generously after aerifying. Greens got more potash. The type of nitrogen was changed and the rates and interval of application were designed to furnish the grass with a continuous and uniform amount of nitrogen. The new program worked wonders on the grass and enabled fungicides to do the job expected of them.

It is only human to blame disease for everything, especially when the signs seem so plain. The examples just cited show the fallacy of that approach. Ability to recognize and evaluate these secondary causes and effects is important. Then one can devise a program to improve conditions for growth; one which will strenghten the grass and thereby help it cope with disease.

The most important management factors include use of the right grass, watering and fertilization. This triumvirate usually makes or breaks the MAN of management.

Grasses differ in their susceptibility to disease, or in their ability to resist it. Seaside is very susceptible to snow mold and would be a bad choice in regions where this disease is bad. Washington, Congressional, or one of the better colonials would be better choices because of their resistance to this disease. The old Virginia strain was among the first to suffer injury from leaf spot. Washington takes dollar spot but is more resistant to brown patch than Metropolitan. The latter is less apt to get dollar spot, but is more susceptible to brown patch. Arlington and Cohansy are very good grasses in the regions where summers are hot. The mixture of equal parts Arlington and Congressional seems to be a good one generally. The new Pennlu strain from Pennsylvania is said to be an excellent putting green grass.

Water management is as important as selection of the right grass. Improper watering is responsible for many bad greens. The tendency is to over water. Some fail to recognize the necessary for hand syringing during hot weather. It is the only way to save shallow rooted turf. Such greens must be watched for wilting on Saturdays and Sundays as well as during the week. Failure to do that is the reason why some greens deteriorate over the weekend. They may be reasonably good Friday night and bad by Monday.

The workman who waters the greens is the key man on the force. He should be selected for intelligence and trained to do the job. Instruction should include something about the why as well as the how to use water.

Drainage is another important item associated with water management. It includes air drainage as well as quick removal of surplus water. Good internal soil drainage is extremely important, especially in regions where heavy rainfall is a probability during hot weather. Tile is not needed when greens are located on a porous subsoil. With tight compact subsoil tile is desirable. The herringbone system is best. The distance between tile lines should not exceed 15 to 20 feet. Trenches should be backfilled with coarse material such as pea gravel. A gravel blanket on top of the subgrade is a desirable feature provided a tile system is installed underneath to remove gravitational water when it reaches the gravel blanket.

Surface run-off is the best way to remove water quickly. Greens should be designed so surface water leaves the green in several directions. Pocketed areas which hold ponded water should be absent.

Good air drainage insures passage of air across the surface to remove moisture laden air during humid periods. When the air in immediate contact with the grass is saturated with moisture dew and guttated water remain on the surface in droplet forms. This provides a favorable medium for disease. Air movement across the green enables evaporation to occur and the grass becomes dry.

Lime and fertilizer affect the well-being of grass in many ways. Both have profound effects upon the amount and severity of turf diseases. The examples cited earlier are proof of that fact. The discussion about lime and about fertilizer was left to the last purposely, because fertilizers are blamed by some for all the ills of turf. Nothing is farther from the truth. Although fertilizers can be misused, no other tool is as useful or has as profound an effect upon turf quality and density.

Lime is the great soil regulator. Need for it must be considered first and then it is easy to devise a sound fertilizer program.

A few plants such as gardenias and camellias need an acid medium. Otherwise they cannot obtain the minute amount of iron required by the green portion of the leaves and stems. Centipede is a good example among grasses. Applications of lime are often fatal to its well-being. At one time it was thought that bentgrasses require an acid soil. This is not true.

Most plants grow best in the range of pH 6.0 to pH 8.0. The range is narrow in many instances - such as bluegrass, alfalfa, etc. Other plants can withstand greater acidity and grow over a wider reaction range. That is the case with the bentgrasses and fescue. Velvet appears to be more acid tolerant than any of the other bentgrasses. The beneficial effects of lime seldom show in the amount of growth. Lime helps grass withstand adversity. The grass on unlimed acid soil starts to turn brown first with the onset of dry weather. The greener grass along each edge of the lime lines on football fields is a good example. The reduction in disease following the use of lime on an acid soil was cited earlier. Sometimes a light dusting of hydrated lime stops brown patch better than anything else.

The use of lime is justified whenever soil reaction is below pH 6.0. A dolomitic type of lime is best when the soil supply of magnesium is low. Dolomite corrects acidity and eliminates a possible soil deficiency in magnesium.

After providing lime, or eliminating need for it, the problem is one of devising a sensible fertilizer program. In doing so this fact must be kept in mind. The farmer depletes the soil by harvesting the crop. Greens maintenance resembles farming in this one respect. The clippings are the crop which is removed. On other turf areas the clippings fall on the ground. As they undergo decay the mineral elements are released and restored to the soil in forms which the grass can use. Plant food losses are confined to nitrogen.

The growing season in Wisconsin is five to six months. Clippings have been weighed and analyzed from one green at Brynwood. During the season the dry weight of clippings from each 1,000 square feet was 100 pounds in round numbers. Where the growing season is longer, the amounts would be proportionally more. The clippings contained about 5 pounds of nitrogen, 2 pounds phosphoric acid, and 4 pounds of potash. The plant food removed during the season was equivalent to a 100-pound bag of 5-2-4 fertilizer. It is significant that there is almost as much potash as nitrogen, and only half as much phosphoric acid. The 5-2-4 ratio is vastly different than 5-10-5, 4-12-4, etc., which have been used in the past. No wonder many greens are becoming low grade phosphate mines and iron chlorosis is on the increase.

Based on the Brynwood findings, bent greens should receive about 1 pound nitrogen, 1/2 pound phosphoric acid, and 3/4 pound of potash each month per 1,000 square feet of surface to replenish the amounts removed in the clippings.

The easy way is to apply the potash and phosphate all in the late fall or to apply one-half in the spring and one-half in the fall. Both are taken up by the soil so they resist leaching. Then use from 1 to 2 pounds of nitrogen per 1,000 square feet per month. The other alternative is to make monthly or semi-monthly applications of all three - nitrogen, phosphoric acid and potash. When this is done, the fertilizer ratio should be something like 1-1-1 or 2-1-2, rather than 1-2-1 or 1-2-1.

Iron chlorosis is becoming more common. It was responsible for many bad greens during the summer of 1954. Most of these greens could have been saved by prompt use of copperas which is ferrous sulfate.

The secret is to use 2 to 3 ounces per 1,000 square feet with not more than 5 gallons of water. The iron sulfate must be left on the leaf. At least 4 to 5 hours should elapse after spraying with iron sulfate before it is watered-in, or before the green is watered. Promptness is important, otherwise the weakened grass will fall prey to one of the many fungus diseases.

It is only natural that discussions of disease emphasize fungicides and their use. However, the role of Management cannot be ignored. Fertilizer and water practice are the things which have profound effects on disease and the effectiveness of fungicides.

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