PROCEEDINGS

of the

16th ANNUAL NORTHWEST TURFGRASS CONFERENCE

Sept. 26 27 28, 1962

WASHINGTON STATE UNIVERSITY PULLMAN, WASHINGTON

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1. Annual Dues payable on or before May 15th each year. Dues are based on annual due date nonprorated.

2. Membership includes registration fee for one person at Annual Turf Conference. Other persons from member organization registration fee $5.00.

3. NO INITIATION FEES ARE CHARGED.

4. Nonmembers may attend the annual Conference by paying $10.00 registration fee. For further information on dues, contact Northwest Turf Treasurer.

It has been an honor and privilege to serve as your President of the Northwest Turfgrass Association during 1961-62. In the years I have been affiliated with this organization, I have watched it grow in membership, interest, and in quality of organization. This has been brought about to a great extent by devoted guidance by your many past presidents and, of course, the enthusiasm and support of all members. I feel that this 16th Northwest Turfgrass Conference has been one of the finest conferences we have ever had, and I know this is only a beginning of something better to come.

I want to give my compliments to Don Hogan, my predecessor, whose organization made my job easier, and to extend my best wishes for a banner year to your new President, Henry Land, Sr. I also express deep appreciation to the board of directors and my committees who performed so faithfully this last year. Continue to support your Association and encourage new membership, for this is the nucleus of a large and important industry--TURFGRASS.

Byron Reed

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TABLE OF CONTENTS

WELCOMING REMARKS

M. T. Buchanan
Director, Agricultural Experiment Station
Washington State University
Pullman, Washington

You folks have come a long way since the time of your first conference to which I welcomed you here in 1946.

The changes you have observed in your own profession and those that I hope you have observed in your land-grant university are indicative of the fact that nothing is so constant as change in our time. One might even conclude that change itself is a value in our culture. I have come more and more, myself, to believe that this is so. In my own case this belief has been buttressed by experience in Pakistan. This is one of those countries in which economic development will proceed more rapidly as people there are willing and able to overcome tradition and custom so as to permit desirable changes to occur.

I should like to visit briefly with you folks today about a number of significant changes that are occurring and that are in prospect for agriculture and for the institutions that have an agricultural orientation--especially the agricultural experiment stations of land-grant colleges and universities. I am glad to talk with you folks, especially, about these matters for the reason that you in a very real sense serve as a bridge between farmers and urban people. And more and more decisions concerning agriculture will be made in the city.

Our Changing Agriculture

First, let us look at some of the changes that have occurred and that are still taking place in our agricultural industry.

Rural farm population in Washington State is 5.7 per cent of total population(1). For the United States as a whole, 6 per cent of the voters are engaged in commercial production of agricultural products (2). Though comparable statistics are unavailable for 1862, it is evident that there has been almost a complete reversal of these figures within the past 100 years.

We can, perhaps, lay some "claim" to additional population under a broad definition of agriculture or agribusiness for the reason that much that was formerly handled by the farmer and his family is now done by those who occupy jobs in the 500 distinct occupations that have proliferated into agricultural industry. These occupations in turn may be classified into eight major fields: Production, Education, Business, Research, Industry, Communications, Conservation, and Service (3).

"In addition to the 8 million people on the farms, there are 7 million people who produce for and service the farms, and 11 million people who process and distribute the products of farms. This means a total of 26 million people are employed in the production, processing, and distribution of food and fiber in America. This is approximately 40 per cent of the jobs in the nation (4)." Thus, even agriculture has moved off the farm. There are more than twice as many people concerned with and dependent on agriculture for a living who do not live on farms than there are those who do.

While 83 per cent of the land is still within farm boundaries, people in urban areas are going to have a much greater say as to what is going to be done with the land in this country, including the 83 per cent now devoted to agriculture (5).

Our productive agricultural plant currently consists of 3. 7 million farms manned by 8 million farm people. Of these 3. 7 million farms, 1. 5 million produce 87 per cent of the total output (6). It is rather generally agreed that one-half of the present farm population could produce all the food and fiber needed until 1975 on less than one-half of the currently existing farms.

Such, on the one hand, is our blessing of abundance and, on the other, our curse of overcapacity.

We in agricultural research and education may take some credit for having had a part in the development of the most efficient and productive agricultural plant the world has known, and, also, by way of this accomplishment to provide the foundation, manpower, and some of the know-how for the world's greatest industrial and service complex. We may take comfort from our contribution to an ample supply and variety of fine, nutritious food for our people at the lowest real price in history. We are pleased with our contribution to our nation's international goals that rely on food and fiber for their accomplishment. And we are pleased to have participated in much research that was both indirectly and directly applicable to human medicine. In the area of our contributions to science, we are proud that half of all of the living American-trained Nobel Prize winners earned degrees in land-grant universities although these institutions make up only 5 per cnet of the nation's colleges (7).

But we are also credited with having caused the surplus problem! And one suggested solution is a moratorium on agricultural research (8).

Agricultural Research, Farm Programs, and Science

On Thursday, March 22, 1962, I appeared before the Subcommittee on Department of Agriculture and Related Agencies Appropriations of the Committee on Appropriations, House of Representatives, as Chairman of the Legislative Committee of the Experiment Stations of the United States under authorization of the American Association of Land-Grant Colleges and State Universities. Following our testimony, which was in support of an increase in fiscal 1963 of $7. 5 million in Hatch funds and an increase of $500, 000 in "Title II" marketing funds, Mr. Horan made the following comments (among others):

"Mark, I do not know whether I ought to mention this or not, because (but) I just have to tellyou what our position is. We are fearful on the Appropriations Committee--this does not extend to others who do not have to work with the budget--that budgetwise we may have painted ourselves into a corner. I think you know what I am talking about. I think we are wasting money in agriculture, but certainly not on experiment stations or land-grant colleges. . . .

"If we could get away from expensive administration costs of our farm programs, we would not have any trouble with these budget items. . . . (9)"

Mr. Horan's comments have encouraged me to seek out some data on the expenditures of the U. S. Department of Agriculture. Remember that the United States Department of Agriculture was established in 1862 primarily as a research and information unit. Current appropriations for agricultural research represent substantially less than 2 per cent of current total expenditures.

I shall leave it to you to decide whether or not you agree with Mr. Horan that the appropriations for the experiment stations and the land-grant colleges deserve a higher priority in comparison with the other expenditures of the U. S. Department of Agriculture. It does seem to me to be quite clear, however, that the chance for obtaining significant increases in federal appropriations for agricultural research is lessened under the present environment within the U. S. Department of Agriculture in which such large and controversial sums are appropriated for farm program objectives that are far removed from research and education.

By contrast, there has been a tremendous increase in total support by the federal government of scientific research. In 1940, for example, total federal government support of scientific research and development was $74 million. Support of agricultural research was $30 million, 41 per cent of the total. By 1961, the total support of scientific research and development had increased more than a hundredfold to $8, 164 million, while the support for agricultural research and development had doubled to $141 million. The federal support to agricultural research as a percentage of total research and development had dropped from 41 per cent to 1. 7 per cent of the total (10).

There is some interest at present on the part of the President's Science Advisor and the Bureau of the Budget in increased funds for the support of basic scientific research in agriculture. This is something in which experiment station directors and research administrators of the Department of Agriculture have a great interest. Farm and commodity organizations and the committees of Congress before whom the U. S. Department of Agriculture budget is heard, however, seem to have much less interest in basic research. Their interest instead seems to be primarily in applied research and service.

What Some of Our Advisors Say

This conflict in interest and advice seems to prevail in the counsel we receive these days from a wide variety of sources. Let me try to classify and describe a number of changes in emphasis that are currently being recommended.

More Marketing, Economic and Rural Sociological and Adjustment Research

One of the earliest and most persistent suggestions is that greater attention is needed to research in marketing, to the economics of farming and the handling of farm products to the final consumer, and to those economic and rural sociological investigations that will aid farmers and the rest of the economy to adjust to the rapid changes that have accompanied improved technology. Proponents of this line of argument point to the fact that agriculture has moved off the farm. As mentioned earlier, more than twice as many people concerned with and dependent on agriculture for a living do not live on farms than do. Currently, after 100 years of heavy off-farm migration, we are still faced with the need for one-half of our farm people to find employment elsewhere. "Why aren't you doing more to help these people?" they say. "Why do you continue to spend the lion's share of your funds for production research in face of the reversal of conditions now as compared to the time of establishment of the land-grant colleges?"

A Few Areas of Excellence vs. Covering the Waterfront

Another persistent line of questioning through the years by congressional committees indicates their belief that more would be accomplished for the money under a more centrally directed research program than is provided for in the Hatch Act. Others, including excellent scientists, argue for the development of a few programs in depth in each state rather than to attempt to do "something" for everybody. Planned programs among several states, each specializing in its own area of excellence and serving the whole region, are encouraged.

More Emphasis on International Problems

A relative newcomer to this list is the recommendation that we emphasize research on problems of agricultural development in underdeveloped areas in order to make positive contributions to the international goals and foreign policy of the United States. Our goals in these areas are such, they say, that ultimate returns on investments, even of state funds, in such research will exceed returns on current "production-oriented" research.

At least one of the spokesmen for this point of view makes his point vividly, if not diplomatically, as follows:

> "A leader among the land-grant institutions stated recently that 'The experiment stations' directors of the country represent the oldest national system of planning and supporting research with public funds.' What he neglected to mention was the ossification, senility, and infirmities that have crept into this corporate body.
>
> "The level of resources in foreign development and foreign trade analysis... is unbelievably, abysmally low... less than one per cent of the total resources.... This is the product of the thinking in our land-grant agricultural experiment stations.... How magnanimous! How stirring! How imaginative! Never have the opulent many met the urgency of the wanting many with so niggardly little! (11)"

Basic vs. Applied Research and Service

Another classification of suggested research emphasis that goes clear back to our beginnings is that of basic research vs. applied research and service. One could write a book on this. In fact, were even my own writings on this topic pulled together in one place, they would make a sizeable document.

Basic research is deep-digging, systematic search for new knowledge. It does not rely on predicted application for its justification. Yet experience to date indicates that returns to this sort of research are far in excess of those to research that seeks to apply known knowledge to the solution of specific problems--applied research.

In the early years of formal agricultural research, the research personnel were botanists, zoologists, geneticists, chemists, and the like. They applied knowledge in these areas to agricultural problems. Since that time there has been a great proliferation of so-called agricultural scientists--agronomists, dairy husbandmen, etc. Subspecialization has occurred in commodity-oriented areas and by geographic locations. These men have done much excellent work. Many of the best of them are now saying, however, that the water-table in the well of basic knowledge available for application is going down and needs attention; that the easy problems have been solved and the new ones are more complex; and that the solutions of today's important problems demand that new pieces be found to nature's jig-saw puzzle.

Thus, our greatest push for more emphasis on basic research in agriculture is from our best scientists. Their case has received tremendous impetus recently from the upsurge in interest and support to basic research in other areas by both industry and government. In fact, the support and prestige of basic research in these other areas is so strong that we are in grave danger of losing our best people back to their parent disciplines unless we are able to enhance very materially our support to basic research in agriculture.

What about service? This is something all our land-grant college people in agriculture do when they are asked to identify a plant, a disease, or an insect, or when they are asked what to recommend as a solution for a particular problem. None of us claims it. It is obviously not a part of the on-campus teaching program; not research; and it is not off-campus education. Yet, a very significant part of the time of our research people is consumed by it. It is popular. And yet it dilutes our efforts in research and education. Again, many of our best scientists are wondering what to do to emphasize their research activities and de-emphasize service. Some of them and some good farmers, too, point out that the educational level of our farmers is now very high, especially in Washington State. Can't they read?

What Criteria Should We Use in Choosing Future Emphasis?

So much for the classification of a few of the kinds of suggestions we receive for emphasis. As you see they are to some extent conflicting among themselves.

What criteria should we use in evaluating these suggestions? The immediate, primary interests of producers? The long-run interests of producers? Demonstrated and probable returns on investments made in research? Probable scientific accomplishments? The interests of all of us as consumers and citizens?

Though we have moved somewhat in the direction of several of these "type" recommendations, we are still, I believe, conducting a program primarily of immediate interest to our own producers of farm products. This we have done and are still doing because of our traditional orientation;

because there is far more good work still to do in these areas than there is likely to be money to support it; and because we have felt that we needed to do this in order to get continued and growing support for our programs.

An independent study by Dr. T. W. Schultz of the University of Chicago indicates that society has reaped a 40 per cent return on its investments in agricultural research (12). This is good. Thus can we defend the status quo.

What direction do we move in order to improve it? His studies also indicate a 700 per cent return to basic research. The answer won't be a single one; it won't be one that will last forever; and it won't be one that will suit all concerned. I have lots of faith, however, that a satisfactory answer will be found.

Your group has been among those that have supported from your own funds programs that are of major interest and concern to you. This type of support for applied research and for educational and service activities is growing. We are glad of this because it enhances our ability to keep such programs moving despite increased costs and pressure for changed emphasis.

Your further comments and suggestions will be welcomed as we all strive to change in a manner that will continue to contribute to progress.

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1. 1960 Census.

2. Wall Street Journal, July 23, 1962, p. 6.

3. Proceedings, Agricultural Board, Volume X, 24-25, April 1962, p. 28.

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5. T. C. Byerly, Proceedings, Agricultural Board, Volume X, 24-25, April 1962, pp. 13-14.

6. Orville L. Freeman, Address at Third Annual Business Conference of the University of the Pacific, Stockton, California, April 13, 1962.

7. Richard Bradfield, Talk before 2000 scientists at the meeting of American Association for the Advancement of Science, Denver, Colorado, March 1962.

8. Stanley Andrews, The Farmer's Dilemma.

9. Department of Agriculture Appropriations for 1963, Hearings before a Subcommittee of the Committee on Appropriations, House of Representatives, 87th Congress, 2nd Session, Part V, p. 355.

10. Adapted from Federal Funds for Science (NSF 60-80).

11. Sherwood O. Berg, Evaluation of Land-Grant University Research Activities. Paper for presentation at the conference on "Optimizing the Use of Food and Food-Producing Resources in Economic Development." Iowa State University, Ames, Iowa, February 22, 1962, pp. 13-16.

12. T. W. Schultz, Why Continue to Add to the Excess Capacity of Agriculture Through Research? Prepared for the White House Agricultural Panel on Science and Technology, May 24, 1961. Paper No. 6107.

PANEL DISCUSSION OF FUNDAMENTAL ASPECTS OF TURFGRASS SOILS

Roy L. Goss, Chairman
Bill Bengeyfield
Milt Bauman
Louis Schmidt

It has been pointed out to you that this conference will be conducted in the form of panel discussions. In order to preserve the idea of a panel, each person on the panel will be given a few minutes to discuss the topic assigned or the topic of his choice. After each panel member has had an opportunity to discuss with you his topic, the entire subject will be opened to the floor for debate, the entertainment of other ideas, and general discussion regarding the subject.

Regardless of the amount of talk that can be given by panel speakers, there are always points existing in some of your minds that are not clear, or that were not covered, or that you just don't agree with. In this case it is your opportunity and responsibility to try to obtain satisfaction from the particular speaker who talked on the subject.

It is a pleasure to be with you and to serve with this panel regarding this most important aspect of turfgrass soils. My panel members today are made up of Bill Bengeyfield, Louis Schmidt, and Milt Bauman. Bill is with the U. S. Golf Association and is the Western Director of the Greens Section. He will speak on "Organic Matter and Pre-Planting Fertility Requirements of Turfgrass Soils." Louis Schmidt is the Golf Course Superintendent at the Indian Canyon Municipal Golf Course in Spokane, and will speak to you regarding the "Draining and Mixing of Soils for Turfgrass Areas." I am sure Louis can pass on to you some real good points from his 30 years of experience. Milt Bauman of the Overlook Golf and Country Club, Bellevue, Washington, will speak to you about draining turfgrass soils. There are few people here who can talk of the subject with more recent and extensive experience than Milt, due to the problems that he has found on his own golf course.

MECHANICAL ANALYSIS, SIEVE ANALYSIS, AND POROSITY TESTING--WHAT ARE THEY AND WHAT ARE THEIR VALUE

Dr. Roy L. Goss

The three physical tests as indicated by the title of this paper have much significance to the modern turfgrass manager. A soil subjected to severe tests of compaction by extreme usage must meet certain physical requirements. The amount of nutrients that a soil holds, the amount of air space as compared to water storage space, and the way that the roots and water penetrate a soil are all interrelated and dependent upon these three physical characteristics.

A great deal of money could be saved if more consideration would be given to these factors. It always costs more to rebuild properly than it does to build the right way in the beginning. No one should rely upon his judgment in determining the exact physical properties of the soil, regardless of the amount of experience, without following laboratory procedures. The following discussion will bring out some of the points concerning the three physical measurements with which this paper is concerned.

Mechanical Analysis

In order successfully to study the mineral particles of the soil, they are usually separated into convenient groups according to size. Even though a classification based on particle size is arbitrary, it does make possible an actual separation and percentage evaluation. A mechanical analysis is a determination of the particle-size distribution of any given soil sample. The mechanical analysis is used in deciding the textural name of a soil as to whether it is sand, sandy loam, or other. This infers, then, that the name of these soil fractions refers to particle size.

Sand

Sand particles range all the way in size from 2 millimeters down to 0.05 mm in diameter. When we consider that there are approximately 25 mm to an inch this gives us a good idea of the size of the sand grains. Sand exhibits hardly any plasticity or stickiness and is influenced little by changes in moisture content. The water-holding capacity is low, and, due to the large spaces between the particles, water moves through very rapidly. Sand particles facilitate drainage and encourage good air movement in soils.

Silt

Silt particles are irregularly fragmental, of diverse shape, and are seldom smooth or flat. Actually, silt particles are very fine sand particles. Quartz is the dominant mineral making up silt. Silt particles possess some stickiness, plasticity, and adsorption, but to a much lesser degree than the clay particles themselves. Unless silt is accompanied by adequate amounts of sand, clay, and organic matter, it is usually an unsatisfactory constituent. The presence of silt imparts to a soil a fine texture with slow water and air movement. A soil with high amounts of silt is highly plastic, sticky when wet, and becomes hard and cloddy when dry unless it is properly handled. The water-holding capacity of silty soils is usally high, and, of course, silt imparts a heavy quality to soils. The particle size for silt ranges from 0.05 mm to 0.002 mm in size.

Clay

Any soil particle having a size of less than 0.002 mm is classed as a clay particle. The properties as described for silt are the same for clay with the exception that clay particles increase the water-holding capacity, slow down air and water movement, and increase plasticity and stickiness even more than silt particles.

The clay particles or colloids make up a large portion of the chemically active soil separates. Plant nutrients are held either on the surface of the clay colloids or in the platy or lattice arrangement within the clay colloid.

Soil Classification

1. Sands. Sandy soils include all of those of which the sand particles make up 70 per cent or more of the material by weight. There are two specific classes of sandy soils recognized. These are sand and loamy sand.

2. Clays. If a soil is to be designated as a clay, it must contain at least 35 per cent of clay particles and usually not less than 40 per cent. If clay makes up at least 40 per cent of the total soil weight, the class name is usually sandy clay, silty clay, or simply clay. If a soil is a sandy clay, quite often the sand content will be higher than the clay content itself; and likewise in silty clays, the silt fraction usually exceeds the amount of clay.

3. Loams. In mechanical composition, a loam is about midway between sand and clay. A loam soil should contain a mixture of sand, silt, and clay particles that exhibits light and heavy properties in about equal proportion. In a loam soil the percentage of sands is usually less than 50 per cent of the total weight.

Sieve Analysis

Sieve analysis is the result of passing a given weight of soil through a series of sieves ranging from coarse to very fine where the separated components are expressed in percentages of the total weight. For practical purposes, in the turfgrass field, sieves of the sizes of 2 mm, 1 mm, 1/2 mm, 0.25 mm, and 0.15 mm are all that are necessary for making a good sieve analysis. If one hundred grams of a good air-dry soil are passed through this series of sieves, the particle sizes will be separated out and can be expressed in percentages. For practical purposes, sand particles smaller than 0.25 mm in size are too small or too fine and should be avoided if possible in construction, particularly on putting greens. Unless a mechanical analysis has been previously run, the weight of soil passing through the 0.25 sieve is meaningless since we would not know how much of this material is silt and clay. For example, if 40 grams of the soil passed through a 0.25 mm sieve and the mechanical analysis revealed that the combined silt and clay content was 18 per cent, then 22 per cent of that passing the 0.25 mm sieve would be fine sand.

In making a mechanical analysis the size range of the sand particles is not indicated. A mechanical analysis will indicate only the total amount of sand in the sample. Hence, to learn the important facts about the sand, we must run the sand through sieves to determine the particle size. It is common knowledge that very fine sand particles will increase the compaction, reduce water and air infiltration, reduce the amount of air space, and restrict root growth.

Porosity--Methods of Determination

The pore space of soil is all space occupied by air and water. For the most part, the amount of pore space is determined by the interrelated influence of texture, compaction, and aggregation. Considerable differences occur in the total pore space of various soils. Sandy soils show a range of from 35 to 50 per cent pore space while heavy soils vary from 40 to 60 per cent and even more in cases of high organic matter and granulation. This may come as a surprise to many persons who would normally think that there is more pore space in the lighter or sandy soil group. The important thing in this case, however, is the size and distribution of pores.

Size of Pores

We recognize two types of individual pore spaces, Macro and Micro. The Macro pores readily allow the movement of air and percolating water. In contrast, the Micro pores greatly impede air movement, and water movement is largely restricted to slow capillary action. Hence, in a sandy soil where the total pore space is low, the movement of air and water is surprisingly rapid due to the dominance of the Macro pores. In heavy soils the Micro pores are the dominating pores and often maintain themselves full of water and have little space for air. Aeration in heavy soils frequently is inadequate for satisfactory root development and desirable activity. Hence, the size of the individual pore spaces rather than their combined volume is the important consideration.

Most soil physics textbooks point out that an ideal soil should have the pore space about equally divided between large and small pores. Let us say that this type of pore space distribution would probably be suitable for normal agricultural purposes, but for most turfgrass purposes, particularly where heavy traffic and compaction is likely to occur, the amount of noncapillary pore space should be in the order of 60 per cent or greater.

Porosity Determinations

The porosity of a soil is calculated from the real and apparent specific gravity. The real specific gravity represents the weight of one cc of solid particles. The apparent specific gravity or volume weight is measured by weighing a given volume of soil in its natural structure. It represents the weight of one cc of soil and pore space. The total pore space of a soil can be calculated from the following formula:

$$\% \text{ pore space} = \left(1 - \frac{\text{apparent specific gravity}}{\text{real specific gravity}} \times 100\right)$$

This formula will give the volume percentage of the pore space, but does not characterize size of the pores. The total capillary and noncapillary porosity may be calculated from the volume, weight, moisture content, and density of the soil particles. The capillary porosity is equivalent to the moisture content in per cent by volume. The noncapillary porosity is the difference between the total and capillary porosity.

Inasmuch as there are several other physical considerations that should be made of soils, the foregoing discussion has pointed out a few of the things of which we as turfgrass managers must be aware in order to supply the best media for turfgrass growth.

References

1. The Nature and Properties of Soils, Lyon Buckman and Brady, Fifth Ed.

2. Soil Physics, L. D. Baver, Second Ed., 1948.

ORGANIC MATTER, THERE'S NOTHING QUITE LIKE IT

Bill Bengeyfield
Western Director
U. S. G. A. Green Section

Your conference is stressing fundamentals and rightly so. However, it is sometimes difficult to combine material designed to be instructive and, at the same time, make it entertaining. Therefore, you may be in for a treatment rather than a treat.

Organic matter--What is it and what does it do? I suppose the best definition would be that organic matter is plant and animal residues in various stages of decay. Bark, roots, manures, worms, insects, leaves, and similar materials are constantly being acted upon by bacteria, fungi, and actinomyces. These minute organisms break the raw organic matter down into a material we know as humus.

It is difficult to define humus accurately. There is no definite chemical composition for the material, but it generally is dark colored and has uniform physical characteristics. It is colloidal in nature (i. e., made up of fine slate-like particles), and this colloidal property is an important one. It acts as a "buffering agent" in the soil and reduces injury to plants by toxic substances and soluble salts.

Humus, when mixed with the soil, improves structure by causing greater granulation and thus better aeration and drainage. Humus also acts as a soil reservoir for stored moisture. Plant nutrients such as carbon, hydrogen, oxygen, nitrogen, sulphur, phosphorus, are stored by it as well. Carbonic acid is generated by the decay process and this liberates insoluble soil nutrients. Thus, humus is often referred to as a great "mobilizer" of soil nutrients.

Humus is also a source of energy food for soil microorganisms that bring about the important nitrification processes and other life functions within a soil. And, of course, a high humus content increases surface resiliency which is so important on our putting greens.

There is frequently confusion over the fact that organic materials are not necessarily fertilizers. For example, organic sources such as most manures, mushroom soils, peats, sludge, compost materials, sawdust, and rice hulls have little or no nutrient value.

On the other hand, there are organic fertilizers such as castor bean pomace, treated activated sludge, guano, and certain manures, as well as urea which is synthetic organic fertilizer. The organic fertilizers are not necessarily good materials to increase organic content of a soil mixture. It is important, therefore, not to confuse organic sources and organic fertilizers. They are two different things.

The next question that comes to mind is "Are all organic materials of equal value?" The answer is an emphatic no! Rates of decay of the various organic materials mentioned above and their general character will vary. Therefore, these differences must be considered in placing a value on an organic material.

For example, manures frequently contain from 70 to 80 per cent moisture with only 20 to 30 per cent dry matter. Manures decay rapidly and in a short time only about 2 or 3 per cent of the original weight remains as humus.

Spent mushroom soil supplies even less humus than manure. In fact, many authorities doubt whether it may be justified as a permanent source of organic matter for soils.

Sludges and most other organic by-products are of the same general character as manures. There is a rapid breakdown with little resulting humus for permanent improvement.

The peats are the most desirable forms of organic materials. But these too vary considerably in structure, state of decomposition, capacity to absorb water, organic content, and pH reaction. Peats generally fall into three categories: sedimentary peat, fibrous peat, and woody peat.

Sedimentary peat is composed of a mixture of water lilies, pond weed, pollen, plankton, etc. These very fine particles mix with silt and clay deposited in shallow lakes and ponds. They are sticky, plastic, and of little value for soil conditioning. They are of no value for turfgrass production regardless of the price.

Fibrous peat is a mixture of sedges, mosses, reeds, grasses, cattails, etc. These are the best for our purposes. They have been preserved under water, and this type of decomposition left them highly resistant to further decay. Long-range benefit is derived from their use. Pennsylvania Experiment Station has found that over 70 per cent of organic matter from fibrous peat remained in the soil after a ten-year period.

Fibrous peat comes in several different forms. The "raw peat" is sold just as it comes from the bog. "Cultivated peat" is nothing more than the raw peat that has been tilled and broken up to hasten decay. "Moss peat" is usually from sphagnum mosses and is equally suitable for soil conditioning.

The woody peats result from ages of breakdown of deciduous and coniferous trees and their associated undergrowth. This is not a bad source of organic matter, but it does have lower water-holding capacity and is less desirable for turfgrass purposes. Sawdust might be referred to as a woody peat and has the advantages of being inexpensive and easy to handle. However, before use in turfgrass soils, it should be well composted and well rotted in order to reduce nitrogen tie-up.

There are several new soil additives or amendments now offered on the market. Most of these are highly inert and should persist over a number of years. Examples of these materials include the calcine clays, mica products, cinders, and pearlite. When compared with the functions performed by humus in the soil (as discussed earlier), one can see that these synthetic amendments will not fit all of the advantages of natural organic materials. Actually, little is known of their long-range value or how they compare with peats and other organic materials over the years. If they are to be used as a substitute for natural organic matter, it should be on a trial basis only.

Perhaps the last question that can be answered here is "How much peat or organic matter should there be in putting-green soils?" Considerable work has been done on this problem, and the consensus now is that from 15 to 20 per cent by volume of the soil mixture should be in organic matter. Organic matter becomes more important as we go toward higher sand content in putting-green soils.

Let me summarize by saying, "There is nothing quite like organic matter for good soil development."

DRAINING TURFGRASS AREAS

Milt Bauman
Overlake Golf Course
Bellevue, Washington

To begin with, we will talk about field drainage such as would be encountered in draining turf areas in parks, cemeteries, and gold course fairways. As a rule, but not always, an area that requires internal drainage is a layered soil, a topsoil on top of clay or hardpan, or silt on clay or hardpan. Any layered soil will have a drainage problem. The heavier the soil, the more extensive the drainage must be. It is possible to achieve this drainage by ditching and back filling with any material that will carry water readily, such as gravel; cinders have been used, but the proper way is to use drain tile.

The man doing the drainage must consider the topography of the area to be drained, and determine where his main drainage ditches should be and where his laterals will pick up the most water.

The purpose of the main drainage ditch is to carry the water away rapidly from the lateral ditches; therefore, this tile should probably be larger than the laterals, depending upon the number of laterals that will drain into the main drainage ditch. The main ditch should have a continuous gradual fall. If it falls too fast when operating at capacity, it will blow out and take out one of several sections of tile. It should not be so flat that water will lie in it, as it may silt up and not operate efficiently. The main tile should be laid on a firm foundation. If the soil is not firm, pea gravel or lumber may be used. We cover the tile completely with drain gravel or pea gravel, the joints being fitted closely together as this line just carries water and does not pick any up. The reason for the gravel is to keep the tile line clean. After the tile is covered with gravel, we cut a strip of tar paper wide enough to cover the ditch and place this on top of the tile gravel. This will keep the dirt and silt from working into the gravel and tile. It is much faster than cutting tar paper and wrapping the individual joints. The main ditch may be back-filled with native soil.

The laterals are the lines that pick up the water from the ground, and, as a rule, are placed lateral to the slope of the ground. The ditch should have enough slope or fall to carry the water to the main line.

Most soils have a topsoil and a subsoil. The water as a rule moves faster through topsoil than subsoil, unless the subsoil is a gravel bed or sand bank. The water will pass through the topsoil, and as it meets the subsoil, it will stop and follow the subsoil down the slope. The point where the topsoil meets the subsoil is where you will pick up the drainage water. You will place your title in the lateral ditch the same as in the main ditch (tile spaced $\frac{1}{4}$" apart) and cover with drain gravel or pea gravel. Then the ditch should be back-filled with pea gravel to above the point where the topsoil meets the subsoil. The rest of the ditch should be filled with a good sandy loam.

In areas where you have pockets and the water stands, even though there is tile underneath, some provision must be made to let the water into the drainage ditch. We use 2"X12" cedar planking flush with the ground. These may be removed and cleaned periodically. They do not look as nice as grass, but do look better than a mud hole and take water rapidly.

Draining tees, putting greens, bowling greens, or any intensely used turf areas require a more intensive drainage. Three types of drainage should be considered--air drainage, surface drainage, and internal drainage. Air drainage is the movement of air across a turf area. The air will help dry the grass and will help to prevent the formation of turf diseases. Surface drainage is the contouring of the ground surface so there will be no standing water on the grass following irrigation or heavy rains.

In placing surface drainage on a putting green, the water should leave the green in at least two areas and more if possible. If the water is run off in a single area you will create a wet or soft spot where your surface drainage accumulates.

In this day and age, most putting greens are manufactured. By this we mean we mix the soil to proportions of sand, soil, organic matter, and possibly soil amendments such as pumace, calcined clays, or vermiculite.

If the subsoil is heavy enough that tile drainage is required, the subsoil should be graded in a manner that will give it good surface drainage, as the water that moves through the topsoil will follow the contour of the subsoil as it reaches it. There should be no water pockets in the subsoil, as it could well result in a water pocket and soft spot in the turf above, even though there may be a good, well-drained topsoil above the subsoil.

The tile should be embedded or trenched into the subsoil. The amount of tile used would be determined by the porosity of the subsoil and by the slope of the subsoil.

If the subsoil is reasonably flat, more tile will be required than where the subsoil slope is steep. The tile should be spaced ½" apart, covered with drain or pea gravel. The whole area should be covered with a minimum of 12" of overburden from a gravel pit. All contouring of the green should be made with this overburden material and the top 10" or 12" mix should be placed on top.

The overburden in this area will run from 85 to 89 per cent sand, and drain very readily. With this material for a base rather than gravel, there is a very small change in capillary action from the top mix to the overburden. This material is excellent to back-fill any drainage ditch, and is one of the most economical materials we can use. Yet, it has enough clay, silt, and organic material to grow turfgrass.

There are three types of tile drainage systems. Gridiron is made of 90 degree laterals on one side of the main line. Herringbone system is made of laterals coming in at an angle from both sides of the main line. In both the gridiron and herringbone systems the lines are perfectly straight and are spaced an exact distance apart. The other system is random tiling, the one most commonly used in field drainage. The herringbone or gridiron systems are more adapted to an area such as a putting green. In random tiling you have no set pattern and place the tile wherever it will pick up the most water.

There are probably more systems and many more different ways of drainage that are very successful.

This paper is presented on nine years and 14 miles of drainage experience, and the methods mentioned above have proved to be the best and most economical in our operation.

GRADING AND CONTOURING SOILS

Louis Schmidt
Indian Canyon Golf Course
Spokane, Washington

The two most important topics in green construction are contouring and soils. Probably the most important of these two is contouring. In building a green we must think of all the surrounding area.

Where mounds, traps, and bunkers are to be used they also must blend into the green area. The next tee must also be included in the whole picture. Greens are built large to give a lot of cup settings. Large greens will also give us several ways to drain off the excess surface water. Mounds, traps, and grassy hollows can be used to divide the different cupping areas, making for a more exacting approach shot. Mounds that are close to or running into the green should be only a few feet higher than the green itself. Traps should be just high enough to be seen from the fairway. Large mounds could be used farther away from the green, but should not drain on the green or into a trap. The apron must command considerable attention. It should be of sufficient width that it will allow players to spread out. Mounds, traps, etc. should not be placed so as to funnel traffic and cause worn paths.

If it's possible, plan the next tee short of the green. This will allow players to leave their carts and bags in a larger area and spread traffic.

On a hole with the shortest and easiest approach shot we might build the smallest green and the most interesting traps and bunkers. We could build the largest green with a minimum of hazards on the hole with the longest and most difficult approach shot. With the high cost of labor, it would be to our advantage to make all grades and contours so they could be mowed with powered equipment. The fancy traps with necks of grass running into the sand, sharp curves, and ridges should be eliminated to cut maintenance costs. Some of the old-time construction faults really show up with our increased play. Greens that are built into a hillside where all the water can run onto a green, fairways that drain to and on the green, greens that are cupped in the center are all headaches now and some are still being made.

If a major building or remodeling job is contemplated, a competent golf course architect should be consulted. He will save many a headache for the superintendent and many dollars for his club.

We who have older courses are sometimes guilty of overwatering greens to try to get them to hold a pitch shot. We know this is not the answer. With an average of more than a thousand rounds of golf a week and the daily use of powered equipment on wet greens, we bring the fine particles in the soil to the top, sealing it so the air is shut out. This causes the roots of the grass to come to the top and it becomes necessary to water more frequently, thus starting a vicious circle. The only solution is to change the texture of the soil. We know each golf course has a different type of soil, and there may be several different soils on the same course. Soils on greens need to absorb water and air. Studies have shown how much this is. We cannot doubt that they are right. Also, the types of soil that will absorb this amount of air and water are known. The structure and porosity of the soil govern the rate of movement of air and water into the soil. Also, they govern the rate of water movement through the soil to drainage depth. This in turn governs the toxic gases that are in the soil. It could have a direct bearing on the amount of turf diseases. We are very fortunate to have in the Northwest at Puyallup, Washington, a staff of soil experts that can make a mechanical analysis of your soil. Follow their recommendations to the letter. Mix all your soils off-site. Mix enough for all your work on greens and enough for several top dressings.

Follow this with good management practices and give the golfer a better course to enjoy.

QUESTIONS AND ANSWERS FROM THE FUNDAMENTAL ASPECTS OF TURFGRASS SOILS

Question

Is there any simple way for the layman to determine millimeter sizes in his turfgrass soils?

Answer (Dr. Goss)

Yes, one can use such things as windowscreen for determining sand particle size. In this case, you merely have to know how many meshes there are per inch. Since there are 25 millimeters per inch, then some simple arithmetic will tell you the rest. You can, if you like, go even further and use standard sieves.

Question

Does the Experiment Station have facilities for running mechanical sieve and porosity analyses?

Answer

We have been doing some mechanical and sieve analysis work for some people who have sent in samples. We have the proper testing equipment for mechanical analysis, and, of course, we have sieves where we can determine the sand particle size, but we do not have porosity-testing equipment. We probably will be going into this more in the future.

Question

How much sand, silt, clay, and organic matter is necessary to make up a good soil?

Answer (All panel members are asked to participate in this question)

Milt Bauman: I would say that the important thing in determining these factors is what type of drainage do you have to consider. Certainly, there would be some considerations with lawns, and you would have to consider others with putting greens; however, to me this drainage factor is very important. I believe that a good soil for turfgrass use would contain about 65 per cent sand, about 25 per cent sandy loam, about 10 per cent clay, and the rest organic matter.

Bill Bengeyfield: I think the most important thing, as Roy Goss has pointed out, is the use that will be made of this turfgrass area. About 60 per cent sand, 20 per cent sandy loam type soil, and 20 per cent organic matter by volume usually makes a good putting green soil. This is the result of studies that have come out of the commercial laboratories that are doing porosity testing and making recommendations for putting greens. Another important thing to consider, of course, is the type of clay.

Question

What percentage of the soil should be pore space for maximum drainage and water-holding capacity?

Answer (Dr. Goss)

It is generally figured that the pore space should be divided between capillary and noncapillary pore space. Bill Bengeyfield has already given you some figures on this, and it was pointed out earlier that about 40 per cent of the soil should be pore space. For good drainability, it might be better if we consider something like 60 per cent noncapillary pore space and 40 per cent capillary, and in this manner we would be sure that the drainage would be better.

Question

Do the soil amendments such as vermiculite, turface and others replace the need for organic matter in the soil, or do they replace the fraction sand?

Answer (Louis Schmidt)

I think that vermiculite has a place and some of these others do also, but I do not think they would replace organic matter.

Milt Bauman

I go along with Louie. I don't think they will replace organics. I think the chief reason for these materials is for water movement.

Bill Bengeyfield

Vermiculite has a place, but not in putting greens. I think it is better for packing instruments and such things as that, than to put it into putting greens. I feel that vermiculite will lose its structure, but not such materials as the calcined clays.

Roy Goss

In the April 1962 issue of Golf Course Reporter, there is a good symposium on these soil mixtures and amendments, and I think every one of you ought to read it. One important thing that we must remember is that such materials as the calcined clays actually have no base exchange capacity and can hold nutrients only when they are in solution and held within the pore spaces of the aggregate.

Question

What depth of soil are we talking about when we normally consider the pore space?

Answer (Roy Goss)

I believe we are talking about the normal depth of soil where roots usually grow and on golf course putting greens; this would not be any deeper than 12 to 14 inches. A lawn or other play areas would be around 12 inches deep.

Question

How about the introduction of wood fiber?

Answer (Roy Goss)

Of course, you must remember that the nitrogen requirement goes up. It is difficult to say exactly how much nitrogen would be required when wood fiber is used, so let's just service the needs of the plant. Fertilize it when it shows the need.

Question

What is the organic level content of most of the soils?

Answer (Dr. Halvorson)

It depends on where the soil comes from. On the sandier sites, the organic matter is very low--only 1 per cent or so, but in some of the older established turf soils, the organic matter will run over 8 per cent.

Question

After a number of years, do you feel it would be necessary to retill a putting green to get it back into reasonable structure?

Answer (Bill Bengeyfield)

In New England it is often said that when a putting green becomes 15 years old, it is time to rebuild it. I do feel that when the green is not performing properly, perhaps not draining properly, and it is not playing right in any respect, then it should be rebuilt. I don't think there is any particular age that we can assess as to when a green should be rebuilt.

Milt Bauman

As far as I am concerned, in the building of a putting green the use of a rototiller certainly should be outlawed. I feel you can do a lot better job with a disk. A rototiller will just flop it up in the air, let it come back down in place, and maybe even let some of the fines separate from the coarse material.

Question

Should the soils be mixed on or off the site?

Answer (Louis Schmidt)

I think they should be mixed off-site. You can mix them with a loader, backend blade, disk, or what, but the main thing is to mix them off the site and then place them on the putting green area.

(Roy Goss)

This off-site mixing is what we used on the Joe Albi Stadium in Spokane, and we think we did a real good job on this and hope it will play according to the way we designed it.

Question

How do you determine the source of water for drainage, and, more specifically, how do you determine the direction of flow?

Answer (Milt Bauman)

I find a wet spot, dig in immediately above it, and I usually find a seam of water. You just can't stand back and look at it and find it; you have to dig down and find it. Sometimes you can find a wet spot, follow it up the hill and find the source, and save a lot of wet ground.

Question

How deep do you put tile lines?

Answer (Milt Bauman)

It depends a lot on the degree of drainage you are after. They should be deep enough that you can cover them over to be out of most of the grass roots, and they must be deep enough to pick up the source of supply. Some of the water we have is close to the surface and our drain lines are necessarily shallow; others are deep.

Question

How far apart should these tile lines be placed?

Answer (Milt Bauman)

It depends on how extensively you want to drain it and the type of soil you have to deal with. I might give you an example that on a 126-yard hole, we have 2,600 feet of tile line and I don't think there is enough there. I feel that when some of these situations are as bad as this one, it might have been better in the beginning to strip off the problem soil, grade and drain the sub-base, bring in sandier soil fill, and place the sod back on this.

Question

Now that we have determined how soils should be mixed and we have done it this way, why is it that some of these golf courses are sanding their greens?

Answer (Roy Goss)

Even though the procedure is not correct, some courses are attempting to dry up the course by sand applications to the surface. This is merely hiding our own heads in the sand, because the problem that is causing wet or soggy surfaces certainly is not in the range where the sand can help, but is deeper down in the soil profile and should be eliminated.

Louis Schmidt

I have practiced the sanding of my greens each spring for the last ten years. I have heavy soils at Indian Canyon, and I feel as though the sand has helped my greens.

Milt Bauman

Personally, I am against sanding greens. There is no doubt in my mind that we are going to build layers. You may firm the green up a little in the winter, but next summer you are going to get more shallow roots.

Bill Bengeyfield

I'll go along with Milt on that; however, I think that Sam Zook has something to say about this since he has done this for a number of years with real good results. The way it was done at Waverly was to aerify about three times a year, taking off the old plugs, and reapplying a fairly sharp sand. If you are going to use the sanding program, you must aerify regularly.

Roy Goss

I think Bill has hit at the real source of the trouble. That is, with mechanical equipment you are not going to get down over three to three and one-half inches anyway. If your trouble is below this, you had better just rebuild these greens in the first place.

Question (John Zoller)

How about using sands for firming a surface to prevent tracking?

Answer (Roy Goss)

You can use some sands for helping firm a surface, but it still comes back to the original problem. If the soil is draining properly, and it is of the right texture, you are not going to have soft, wet surfaces; hence, no need for an application of sand. However, if the surfaces are real wet and soggy and drainage is poor, then probably you will hurt little by applying sand to these because they should be rebuilt anyway.

Question:

Do you think we will have more layers developed in a wet climate than we have in a dry climate?

Answer (Bill Bengeyfield)

You will have some layering due to soil separation, but I don't feel qualified to go into it any deeper.

Roy Goss

You will destroy the structure and you certainly will have silt and clays migrating to the surface, because of puddling and packing from traffic. This certainly will contribute to layering, and, of course, this is more prevalent in the wet areas than in the dry.

Question (A. V. Macan)

Isn't it customary to top-dress your greens with the same material from which they were constructed?

Answer (Milt Bauman)

If your top-mix is suitable and grows a good putting green and is of the right particle-size distribution, then that is what you should definitely use. If the putting green mix was not quite right, then maybe you should change it some.

Question

To what extent does the added soil (straight sand or others) become a part of the subsoil after it has been applied?

Answer (Bill Bengeyfield)

If this is applied as a top-dressing over sod, they you are not making a contact and you can definitely get a layer. In this case, some method of cultivation is necessary to make this soil contact.

Bob Wiley

The point is that so many people think that these soils actually do move by themselves, and this is the point at which we are trying to get. They do not move without the aid of other mechanical equipment.

Henry Land

If you verti-cut and aerify it before top-dressing, then I think you are going to be able to help do this mixing job.

Ken Putnam

I have applied both sand and turface in holes of putting greens, and after some time I can still find the turface but I can't find the sand. It is my feeling that this sand has moved.

Roy Goss

I don't think it is so much a case of moving as you have just lost the identity of it. Your putting greens are already very high in sand content, and you could easily lose a lot of sand that you have applied. Sometimes silt can move in itself and blend in with the added sands and tend to mask the identity of the sand. We have already admitted that sands, silts, and clays move, but certainly not large sand particles.

Question

What would make a good top-dressing, considering the fertility, organic matter, etc?

Answer

Certainly the amount of top-dressing that would be applied would be determined by whether or not the green is being aerified or whether any other mechanical treatment is being used. A person should be very careful about the amount of fertilizer applied to top-dressing, since severe burns can result. Top-dressing materials should be fairly high in organic content (20 per cent by volume) and high to sand, 70 per cent or more.

Question

Is there any harm in verti-cutting your plugs back in?

Answer (Bill Bengeyfield)

No, I don't think there is any harm in doing this, provided your conditions are proper and your soils are good. If you want to true up to the surface a little more, then some top-dressing may have to be added in addition to these verti-cut plugs.

Question

How long does it take peat moss to break down and how much does it actually break?

Answer (Roy Goss)

It depends on the amount of air, water, fertilizer, and micro-organisms in the soil. Peat moss will certainly break down to the final components, just like any other organic material if these weathering and chemical factors are operating. The time varies from two to ten years.

PANEL DISCUSSION OF FUNDAMENTALS OF GROUND SPRAYING

L. George Mock, Jr., Moderator
Dr. Lambert C. Erickson
Dr. Roy L. Goss
Bud Johnson
Don Mock

Introduction

L. George Mock, Jr., Moderator
President, Regional Chemicals, Inc.
Seattle, Washington

First, I would like to introduce the members of this panel discussion, where they are from, and what they do. First is Dr. Lambert Erickson who is with the Department of Agronomy at the University of Idaho and who is working on weed control problems. Mr. Bud Johnson is co-owner of Scarberry Spray Service, Seattle, Washington, and is a commercial applicator. Mr. Donald Mock is the Service Manager of Sprague Spray Service Manager of Sprague Spray Service, Inc., Seattle, Washington, and a commercial applicator. Dr. Roy Goss is a Turf Specialist from the Western Washington Experiment Station at Puyallup, Washington.

Our panel will present some of the fundamentals of ground spraying with the hope that we can help you better understand the use of pesticides. With the ever-increasing need for their use, pesticides and their proper application must become a more vital part of background knowledge with each of you.

Most of you are presently engaged in the application of weed killers, insecticides, or fungicides. In view of their general use, we will have need for more specific information on the mammalian toxicity of these chemical tools.

There is at present much adverse comment on pesticides. At least part of this is due to our lack of basics on the dangers involving their uses. I wish to enter a term known as LD_{50}. Are you aware of how the LD_{50} pesticide affects you? First, let me explain LD_{50} and why you must learn this factor for each pesticide you or your men apply. LD_{50} is interpreted to mean the amount of any chemical expressed in milligrams versus a kilogram of body weight necessary to kill 50 per cent of the test animals. For example, if we had 20 test animals all weighing exactly one kilogram (2. 2 lbs.) and each of these animals was fed 250 milligrams of technical DDT, 50 per cent of the population would be killed. Thus, LD_{50} is the amount of technical chemical needed to be lethal to 50 per cent of the population of test animals. Therefore, DDT technical has an LD_{50} of 250.

If your question is how does this affect me, here is how. All chemicals have a different LD_{50}. DDT at 250 is considered a fairly safe chemical from the standpoint of applicator, but not all chemicals are this safe.

PRODUCT	LD_{50}
Acti-dione	2
Alanap	8000
Aldrin	55
Allethrin	650
Amino Triazole	2500
Ammonium Sulfamate	3900
Aqualin	46
Aramite	6300
Arsenic Compounds	13
Atrazine	3080
(Baytex)	190
BHC (Benzene Hexachloride)	500
Bordeaux Mixture	300
Butonate	1100
Calcium Arsenate	20
Captan	3000
Carbyne	1300
Chlordane	457
Chlorobenzilate	960
Copper Sulfate	300
Co-Ral	56-230
Cryolite	200
Cyanide (HCN Gas)	3
Cyprex (dodine)	1000
Dalapon (Dowpon)	3860
D-D Soil Fumigant	140
DDT	250
DDVP (Vapona)	56-80
DEF Defoliant	177
Delnav	50
Delrad	850
Dexon	60
Diazinon	125
Dibrom	430
Dicapthon	370-570
Dieldrin	60
Dilan	330-4000
Dimethoate	155-300
Dinitro Weed Killers	30
Di-Syston	12.5
Diuron (Karmex)	3400
DN-111	330
Duraset	5230
Dylox (Dipterex)	450-500
Dyrene	2710
EDB (Ethylene Dibromide)	150
Elgetol	45
EMMI	148
Endothal	40
Endrin	45
EPN	28
Eptam (EPTC)	1631
Eradex	1800
Ethion	96
Fenson	1550
Ferbam	3000
Folex	1272
Fungitox 1-20	230
Genite	1400
Glyodin	4000
Guthion	10-18
HCA Weed Killer	1290
Hepthachlor	90-135
Chloro-IPC	6000
Karathane	8000
Kelthane	809
Kepone	95
Lead Arsenate	7
Lethane	400
Lime Sulfur	1000
Lindane	125
Malathion	2830
Maneb	7550
Menazon	900
Metaldehyde	400
Meta-Systox-R	65
Methoxychlor	6000
Methyl Parathion	9-25
MH-30 (Maleic Hydrazide)	2350
Monuron (Telvar)	3500
Morven	2000
Mylone	650
Naphthalene Acetic Acid	1000
Neguvon	450-500
Nemagon	173
Nicotine Sulfate	55
Omazene	590
OMPA	10
Ovex	2050
Parathion	3.6-13.0
Paris Green	13-22
Pentachlorophenol	210
Perthane	8170
Phaltan	10,000
Phosdrin	6-7
Phosphamidon (Dimecron)	50
Phostex	1200
Phygon (dichlone)	1300
Piperonyl Butoxide	11.500
Piperonyl Cyclonene	2980
Potassium Cyanate	750
Prometone	2980
Pyrethrins	1500
Randox	700
Red Squill	1000-1500
Ronnel (Korlan or Trolene)	1700-1740
Rotenone	132
Ruelene	1000

Ryania	750	TEPP	1.2-2.0
Sabadilla	4000	Terraclor	12,000
Sesone (SES)	850	Thanite	1603
Sevin	540	Thimet (phorate)	3.7
Simazine	5000	Thiodan	110
Sodium Chlorate	850	Thiram	865
Sodium Fluoride	200	Toxaphene	69
Sodium Fluosilicate	125	Trithion	28
Spergon (chloranil)	4000	Urab	5700
Stam	1384	Urox	3700
Streptomycin	6000	VC-13	270
Strychnine	16.2	Vegadex	850
Sulfur	3000	Vikane	100
Sulphenone	1400	Warfarin	150
Systox (demeton)	6-12	Zinc Phosphide	50
Tabutrex	8000	Zineb	5200
Tartar Emetic	100	Ziram	3000
TCA	5000	2, 4-D	666
TDE (DDD)	3400	2, 4-5-T	300
Tedion	14,700		

Know what chemicals you are using, and remember the smaller the LD_{50} number the more dangerous the chemical is to warm-blooded animals, including you.

FUNDAMENTALS

Dr. Lambert C. Erickson
University of Idaho
Moscow, Idaho

A first fundamental principle in ground spraying would usually be considered a physical or mechanical principle. I am going to place one principle prior to all others, and it is this. Know your material, whether it is a herbicide, insecticide, fungicide, or fertilizer. Some questions are: Is it volatile? Is it a contact or translocated material? Is it mobile or fixed on contact? Is it soluble or insoluble? Is it adsorbed or absorbed? What is its leachability? What is its residual duration? It is axiomatic that when the wrong material is used the results will be wrong.

In terms of physical fundamentals the following are placed in order of declining priority.

1. Capacity
2. Versatility
3. Mobility or maneuverability
4. Durability

Deficient capacity of our present spraying equipment is probably the first problem one encounters in this day of unparalled change and expansion in the application of agricultural chemicals.

To do the job now and in the immediate future, these questions in relation to capacity appear paramount.

1. How large an area must be treated in a certain (predetermined) length of time? Must we treat 1, 10, or 40 or more acres in a day?

2. What total volumes must, or potentially could, be required per acre, or 1, 000 square feet, or other unit area?

Illustration:

(A) Suppose you wish to treat ten acres per day, and suppose that the terrain and obstacles are such that your safe travel speed is $2\frac{1}{2}$ miles per hour. How wide a boom can be used in view of the obstacles? Let's assume that ten feet is a workable width. Then:
$2.5 \times 5,280 = 13,200$ linear feet
$13,200 \times 10. = 132,000$ sq. feet per hour
or $\frac{435,600}{132,000}$ sq. ft. (ten acres) $= 3.3$ hours

Assuming 50 per cent of time utilized in filling, mixing, and travel, treating ten acres requires 6. 6 hours with this unit. Increasing the boom width 50 per cent (to 15 feet) will increase the time efficiency, but not by 50 per cent.

(B) Suppose that you desire an application rate of 20 gpa. How large a pump will be required? Spacing nozzles at 20 inches, six nozzles will be required. Select from schedules the nearest desirable size, e. g., Spraying Systems No. 8002 will deliver 21. 6 gal. at 30 psi. or 0. 17 gpm. per nozzle. 0. 17 x 6 = 1. 02 gpm. for 10-ft. boom.

(C) By-pass for spray agitation requires two gpm.
Friction loss estimate 0. 5 gpm.
Total required = 1. 02 + 0. 5 = 3. 72 gpm.

(D) Potential future applications may require 80 gpa. Spraying Systems 8008 will deliver 80 gpm. at 27 psi. or 0. 65 gpm. per nozzle. 0. 65 x 6 = 3. 90 gpm. for boom. Then, 3. 9 + 2 + 0. 5 = 6. 4 gpm. total required. This illustrates that pumps for the proposed job should have a capacity of about seven gpm.

(E) How large should the tank be?
At a spray rate of 1. 02 gpm., 50 gal. would last approximately 49 min. less 5 gal. = 44 min.
At 3. 9 gpm. the solution would last about ten min. What tire pressure psi. will the turf tolerate?

3. Very frequently the immediate question is what will or does my present sprayer deliver per acre. The simple solution is this. Select the spray pressure you desire. Select the spray you will drive. Fill the tank <u>full</u> of water. Spray 40 rods. Measure the number of gallons of water to fill the tank. Then use the following formula.

$$\frac{\text{gallons used x 66}}{\text{length of boom in feet}} = \text{gallons applied per acre}$$

4. Uniformity of spray coverage.
Flat spray patterns usually give more uniform coverage than cone patterns. Spray coverage is based on the distance from the top of the begetation to the nozzle. Eighty orifices spaced 20 in. apart require a vertical distance of 12 in. for single coverage.

(B) Versatility - Definite restrictions must be placed upon the versatility expectations of any herbicide spray unit. Sprayers should not be designed for applying both herbicides and insecticides or fungicides in plant pest control. Major emphasis should be placed on restricting the weight of the vehicle, the size of the tank, the width of the boom.

(C) Maneuverability - Maneuverability may be included under versatility, but there are additional considerations such as: length and height of unit, turning radius, location and accessibility of the control to the operator. All the latter factors should be based on minimum requirements.

(D) Durability - Gear pumps, spring and ball-type pressure regulators, oversize strainers and filters, screen diameters distinctly less than orifice diameters, plastic-coated tank interiors, and avoiding iron and aluminum. Connections will add to the durability of the spray unit and decrease the frustrations incident to continuing operation.

(E) Minimum wind velocity is always an essential in safety of application. Large droplet size, large orifice diameters, flat spray patterns, and minimum pressures are conducive to minimizing spray drift.

SPRAY APPLICATIONS OF FERTILIZER

Dr. Roy L. Goss
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For many years fertilizers have been applied as liquids or dilute liquid sprays to various forms of herbage. Liquid fertilizers have probably been applied more extensively to pasture and hay crops on farms than in any other way at this point. However, the popularity of this technique as it is increasing today will probably make turf the number one crop for fertilizers applied as liquids in the future.

Fertilizers can be applied through irrigation systems by either dissolving dry fertilizers and inducing them into the irrigation line by direct suction or with Pitot or Venturi induction systems. Or they can be applied as concentrated liquids induced into irrigation systems in dilute forms. The system used by most commercial applicators today is tank-truck and sprayer application. In this system, fertilizers are dissolved or added to a given volume of water and sprayed on to the turfgrasses in a large enough volume of water that no injury will occur under normal conditions.

Liquid Versus Dry Application

Liquids have a decided advantage over dry application in some respects. Many homes and estates have turfgrass areas so irregular in shape that dry application of fertilizer is very difficult. In these instances, spray hoses and spray booms are more easily adapted to the areas. Liquid fertilizers also have the advantage of being placed immediately in the root zone of the grasses and are available a little faster. Also, the fertilizer is already in solution and is more uniformly applied to the entire surface.

Dry applications can be made just as fast and perhaps faster than liquid applications because time is not wasted in remixing tanks of fertilizer. However, with dry applications, "overthrowing" of fertilizer pellets by broadcast system into adjacent flowers and ornamentals can sometimes be a problem, and if the material is applied by way of spreader (free-flow), burns due to concentration of the material can occur due to overlapping or in the turns.

During dry, warm weather, dry pelleted fertilizers sometimes have an advantage in the fact that they will sift down through the grass leaves and do not have to be watered in or dissolved immediately to prevent burning. If water is applied sometime during the same day of application (and sometimes this is not too important), little or no burning will be experienced. However, liquid applications can sometimes cause severe burning if: (1) the fertilizer solution is too concentrated, or (2) the day is too warm, or (3) the fertilizer material is not washed off the grass soon after application. Since the burning action of most fertilizers is caused by a desiccation of the tissue from direct salt concentration, the liquid applications certainly have the best chance of producing a serious burn unless the precautions mentioned above are observed.

Another serious factor which often arises that gives the spray man another headache is caused from grass in a weakened condition due to other injury. When a good application of fertilizer is applied to grass in this condition, sometimes the reaction goes the wrong way and the grasses are severely injured. This is notably true in the case of previous herbicidal injury or if the turf is on the dry side at the time fertilizers are applied.

The best possible results of herbicide applications will be obtained if the weeds are in an active stage of growth. A good fertilizer applications a few days before herbicide applications will insure a better kill of the turf weeds and at the same time keep the grasses growing vigorously. This will help to mask any slight injury from herbicides.

Fertilizer Ratio and Intensity Is The Important Factor

Once we have arrived at the proper ratio of nitrogen, phosphorus, and potassium which should be applied to turfgrasses, then quality is affected by the intensity of this application. Research results at the Western Washington Experiment Station indicate that a 3-1-2 ratio of nitrogen to phosphorus to potassium is producing our best quality turf. Generally the higher potassium levels in the formulas are producing turf of superior quality to treatments with lower potassium levels. This application ratio is further substantiated by the approximate ratio in which nutrients are used from the soil by turfgrasses. Turfgrasses do use several times more potassium than phosphorous from the soils. Nitrogen, of course, can be applied to any extent within reasonable limits.

Most of the fast-releasing fertilizers produce the best turfgrass response if they are applied at intervals of one month. Obviously this frequency of application is not economically feasible for either the spray applicator or the home owner. Hence, a happy medium is strived for to help meet these needs. Most commercial applicators agree that the average home owner can afford only about three applications per year. In some instances, they will stand the increased cost of a fourth application. Research results have indicated that with the use of fast-releasing fertilizers a minimum of four applications per year is required to maintain a good quality without having the exaggerated periods of excessive growth and periods of poor growth.

The use of slow-releasing fertilizers whenever they are effective is certainly an advantage to the commercial sprayer. However, most of these fertilizers do not lend themselves to spray applications. Some recend advances in the field of research and development by the commercial companies indicate that such materials as the nitrification inhibitors and the metal ammonium phosphates may be of considerable commercial value to the spray applicators in the future. These materials are slowly available to the plant and can be handled like any other fertilizer. No doubt further research and development will be rapidly forthcoming in this area.

TYPES OF EQUIPMENT AND ITS USE

Bud Johnson
Scarberry Spray Service
Seattle, Washington

One of the most important aspects to ground spraying is the many types of equipment available. Selecting the proper piece of equipment for the job can sometimes be quite a problem to the superintendent of a golf course, cemetery, or park. The fact that the equipment is expensive and not in constant use complicates the problem.

First, you must have proper agitation--some type that will keep your material from settling out and reaching right down to the bottom of your tank and pulling the material back into suspension is needed. This is very important when your machine sits idle during lunch hour or overnight. There are other types of agitation such as jet or injection systems. As of now, we feel that mechanical agitation is the best. This is an agitator with paddles of sufficient length, width, and pitch.

A proper unit should be mobile enough to fit the job, while a trailer unit may be the answer for a golf course or cemetery. The commercial applicators have found the tank truck best suited for their use. One that has separate tanks for various materials with quick shut-off valves to keep materials from interchanging is very necessary. Proper fittings between tanks are a must. For the ground sprayer, two to four tanks are required, and, in a very near future, it may be that even more tanks will be needed.

Hoses that will stand considerable wear and pressures of up to 1, 200 pounds are necessary for commercial applicators.

The amount of material a truck will hold is only of economic importance, since a small truck with adequate pressure and agitation will do as well as a larger tank. Economically, of course, a number of tanks somewhere between 400 to 1, 200 gallons will do the most efficient job with a custom applicator.

Now we come to the selection of materials. There are hundreds available, but it is surprising how few we really have to deal with. Some are set aside because they have phytotoxic effects on a number of plants and are only good for specific problems. Some because they have too short a residual action, and, surprisingly, some because they have too long a residual action. In the past we thought the longer a material lasted and was active the longer a material lasted and was active the better it was. Now, because of the upset in nature's balance with such a buildup of mites when using DDT without an acaricide, and because of having to spray trees in the home owner's yard while there is still fruit on trees, we have to look for stronger materials that give quick kill but have relatively short residual period.

The names Parathion, Guthion, and Trithion may be to some of you just a list of names; to others, at least a few, I am sure, a list of poisons which strike a small note of apprehension similar to the thought of a diamond-backed rattler, tarantula, or scorpion. To us they are neither; they are simply tools of our trade, no more dangerous than a skill saw in the hands of a carpenter, a welder's cutting torch, or a piece of red hot iron to the blacksmith. All are potentially dangerous, but, if controlled by people who know how to use them, are invaluable in our day and age. It goes without saying, before you use these or any chemicals, be sure you understand them, not only how dangerous they can be, but what effect they have; what materials you can use in combination and which materials you can use with the least harm to the beneficial insects.

Regrettably, I do not feel there is a higher authority than ourselves when it comes to selection, effect, and application of these materials, and, while I do not believe we are in any position legally, perhaps, to give specific recommendations, if you have any questions, we can certainly tell you what we would do under like circumstances. What I am saying is that we invite you to add us to your bag of tools.

I am sure one of the insects that makes you turf-conscious people aware that there are trees and ornamentals is the havoc and infestation that tent caterpillars can raise with your willows and other native trees. While the control is relatively simple, do not overlook the use of an acaricide with the use of chlorinated hydrocarbons, or you are apt to find out the hard way that mites generally are much more difficult to control than the caterpillar.

You cannot ignore a browned-out spruce or a cherry tree that becomes dormant in July or August just because you don't use a lawn mower to trim them.

These days when the ornamental crop is fast bypassing the agricultural crop in dollar value, we can no longer ignore it, whether in your backyard or 30 feet from the putting green.

We feel that we fall short in many fields, one of which is the evaluation of experiments of new insecticides. We really need all the help we can get. We are not research men, we are simple applicators; however, the rapidly moving chemical industry is forcing our hand. We must experiment. While it is true we get much valuable information from the Department of Agriculture and Extension bulletins, Experiment Station research from the universities (which I might add comprises a small part of the budget) is done at Experimental Stations under controlled conditions. Maybe "controlled" is a poor word. We do not mite counts and assistance in the field, which is our customer's yard, or your golf courses, cemeteries, and parks.

You must realize, too, we are struggling to raise our public image in the same manner that many of you have done and are doing. To do this, we must increase our knowledge, and that, gentlemen, is our reason for being here today. I know this is only a general idea of the fundamentals of ground spraying in regard to insects, but we invite any questions if you do have any insect problems.

DISEASES OF ORNAMENTALS AND TURFGRASSES

Don Mock
Sprague Spray Service
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I have been assigned the topic of "Diseases of Ornamentals as They Relate to Ground Spraying." This is an extremely broad field about which most of us know very litt. e Since this is a turf conference, I will speak first on those diseases that give us the most problems in western Washington turf.

The learned gentlemen who have preceded me on this panel have now created a turf that is free of weeds, that has been adequately fertilized, and on which the insects have been controlled. Now with proper watering and mowing schedules, we should have a good-looking turf. Then something happens--we start losing the grass because of one or more diseases. In western Washington our main problems come from five main turf diseases: Snow Mold, Fusarium patch, Ophiobolus patch, Red Thread, and Anthracnose. Now when we study the cultural recommendations for control of these diseases, we find some conflicting recommendations. In cases of Snow Mold, Fusarium patch, and Ophiobolus patch, we find that we should avoid high levels of nitrogen. On the other hand, these same recommendations for controls of Red Thread, and Anthracnose advise us to use adequate nitrogen. Now it is not uncommon for us to find all five of these diseases active at the same time of the year. So the cultural recommendations remind me of the wife who tells the husband to have a good time, but be good. Because these conditions actually exist, we feel very strongly that additional research must be done under the conditions that commercial applicators encounter.

Sometimes we feel that the old saying "Let sleeping dogs lie" perhaps should be applied to turfs. We say this because old, neglected turfs have a habit of greening up in the spring, drying out in the summer, and then greening up again after the fall rains come. While a neglected turf, undoubtedly, has had outbreaks of Fusarium and Red Thread and perhaps other diseases, they probably went undetected. Now we have the stage set for the commercial applicator. Mrs. Jones decides she wants something done to make that old chunk of lawn look like the golf course putting green. So the telephone rings and the applicators get a call to go look at this chunk of Poa, velvet, quackgrass, and weeds of all nature, and, maybe if we're lucky, a little bent and fescue. In all probability, the first thing we will recommend is that the lawn be mowed and thoroughly watered. Then after a few days of growth, we will apply a spray of herbicides for control of weeds and clover. Up to this point everything has gone fine. Then we apply a big feeding with a high level of nitrogen. Eighty per cent of the time the lawn will respond and we leave a satisfied customer. We have transformed an old chunk of grass and weeds into a lush green carpet. This is all fine and good, but the problem comes in what happens to the other 20 per cent of the lawns given the same treatment. They come up with the darndest conditions of Fusarium or Ophiobolus patch, and we wish we never had anything to do with them. A few incidences like this and it really dampens our desire to do any turf work. But in our operation we go back to the drawing boards. We used calcium nitrate, ammonium nitrate, and ferrous ammonium sulfate in various combinations. These forms of nitrogen helped in the control of the diseases, but did not allow enough nitrogen to be used at any one feeding to come up with the result that is expected of the commercial applicator. Then in 1959 came the first real breakthrough when

Dr. Roy Goss began to recommend high levels of potash. We found out that we could come up with color without the extremely high level of nitrogen that we had been using up to this time. To take advantage of these factors of disease control with different kinds of nitrogen and color with high levels of potash, we have had water-soluble forms of 24-8-16 manufactured for our own use. This fertilizer is made up of ammonium sulfate, ammonium phosphate, urea, and muriate of potash, keeping our ratio of 3-1-2, but keeping the nitrogen desired from urea at about 50 per cent of the total nitrogen. Further reducing the amount of urea in cool weather, we use 10 pounds of ferrous ammonium sulfate for our spring feeding and moss control. This application is of great value in the cool, wet spring to aid in the control of diseases.

I cannot say whether the iron and/or the sulfur have some control, or whether it is just that we are not using any urea forms of nitrogen that very greatly reduce the outbreak of diseases.

As a preventative in our fall application of 24-8-16, we are using $1\frac{1}{2}$ ounces of PMAS per thousand square feet. Let me emphasize that I said "as a preventative." When we have severe attacks of Fusarium, we apply $1\frac{1}{2}$ ounces of PMAS in 25 gallons of water per thousand square feet. You should note that 25 gallons of water instead of the usual ten gallons are recommended. We do not get control with the use of only ten gallons of water per thousand square feet. I feel this is a direct result of the practice of most research being conducted on turf cut at putting-green height. In the average home lawn that is being cut at about $1\frac{1}{2}$ inches with a heavy thatch, we must increase the amount of water to wet the stem and crown and upper part of the thatch. In any disease control program, we always must put renewed emphasis on cultural practice. We recommend thatch removal, aeration, and lower cutting height to promote better air drainage.

Up to this point I have said very little about Red Thread because it has not been a serious problem for us. We simply grow it out with a good feeding program. In May of this year we had a problem on fescue that I mistook for Red Thread, except that I could never find any "flags." We tried the usual treatment of outgrowing it with no success. Then we tried PMAS with no success. At this point I had Dr. Goss look at several turfs that had developed the problem. It was later identified as Anthracnose. I would like to note that it attacks only the fescue in our case. At the present time, there is no recommended control. We have tried PMAS and Captan with no results to date. The disease has run its course for this year, and the _Poa_ is filling in nicely at last observation.

Snow Mold is very definitely a problem in western Washington. Sometimes it is difficult for us to distinguish between it and Fusarium patch. Especially if at the time we see the turf, it is not active. Last winter we had a terrible outbreak in the Seattle area. PMAS has given us good control.

In summary, I will say:

(1) Use as little nitrogen as possible.

(2) The less nitrogen derived from urea the better, even during so-called summer months, because Fusarium in our area knows no season.

(3) Outgrow your Red Thread.

(4) Use PMAS as the main turf fungicide.

(5) Pray that you don't get Anthracnose or Ophiobolus patch.

QUESTIONS ASKED - FUNDAMENTALS OF GROUND SPRAYING PANEL

QUESTION: In using an irrigation system for applying fertilizers, what may be the results of applying these on steeper hillsides?

ANSWER: (Goss) It's a good possibility you could have most of the fertilizer down in the bottoms, unless you would go to such programs as aerifying and/or the use of wetting agents to help get the water and fertilizer down to and into the soil.

QUESTION: In spraying fungicides with fertilizers, do you get the same effect as in spraying them separately?

ANSWER: (Goss) I can only quote Dr. Gould's recommendations on this. It's all right to put on some fertilizer with the fungicide, but this should be in small amounts. We like to incorporate as little fertilizer as possible, since there could be interactions with the fungicide. One-fourth to one-third pound of available N per thousand square feet with the fungicide would be sufficient to help overcome any burning effect with the fungicide.

PANEL DISCUSSION OF FUNDAMENTALS OF ESTABLISHING TURF

Kenneth J. Morrison
A. G. Law
Dr. Norman Goetze
V. C. Brink
A. V. Macan

SEED BED PREPARATION AND SEEDING TURF

Kenneth J. Morrison
Extension Agronomist
Washington State University
Pullman, Washington

Home owners would like a uniform vigorous turf as an attractive setting for their home. When lawns have been properly established, adapted species and varieties planted, and good management practices followed, beautiful turf is the result.

In preparing a seed bed, remember it is a long-time venture. Good seed bed preparation is very essential in maintaining a vigorous lawn for many years.

After the area has been brought to grade, fertilizer should be tilled into the soil. The area should then be harrowed and raked. The soil should be packed with a roller or float until it is level and firm. If possible, the seed bed should have several weeks to settle before planting. It is easier to make the final grade after the soil has settled.

A corrugated roller is ideal for packing a lawn. It may not be available, and the smooth water-filled rollers for rent at most garden or hardware stores will do a good job. One word of caution--do not work the seed bed with packer or other equipment when the soil is wet.

After the seed bed has been properly prepared and packed, three pounds of bluegrass or creeping red fescue per 1,000 square feet of turf area are recommended for eastern Washington. Three pounds of bentgrass or three pounds of creeping red fescue per 1,000 square feet are recommended for western Washington. It is cheaper to buy and mix your own seed than to buy prepared lawn mixtures.

In eastern Washington, late summer is the best time for seeding lawns. The second best time is in early spring. If seedlings are made during hot weather, it is more important to use a mulch material to keep the soil moist.

In western Washington spring seedings are best. Annual bluegrass, chickweed, and pearlwort will grow all winter, while grass seedings are dormant if turf is fall-seeded.

After the seed has been planted it should be mulched and kept damp. Peat moss, sawdust, or straw make good mulching material. Most areas in Washington have sawdust available, and it is a cheap, weed-free mulching material. It is necessary that additional nitrogen be used to help decompose the sawdust. Straw has the danger of a high weed seed content. If the mulching material is not used, the seed should be covered about one-quarter inch deep. Be careful not to cover the seed too deep.

A whirlwind seeder is one of the best pieces of equipment for turf seeding. The cart-type seeders are also available on the market or for rent. Regardless of the equipment used, the seed should be uniformly distributed over turf area.

TURFGRASS VARIETIES FOR EASTERN WASHINGTON

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Pullman, Washington

There is available today at the market place a vast array of turfgrass varieties, each one supposedly better than the others for a specific set of conditions. For example, there are at least 12 named varieties of Kentucky bluegrass plus an equally long list of proprietary brands, each of which may be touted as the best. The interest in developing new varieties has grown from the widespread use of turfgrass for home lawns, golf courses, city parks, and play fields throughout the United States. The building boom of the 1950's and the move to the suburbs, plus the increased interest in golf, have stimulated both Experiment Stations and private seed companies to develop new, and in some cases, improved varieties of turfgrass. In many cases varieties of the same species are as different as day and night when grown in a particular location for a particular use. In other cases there are no discernible differences among named varieties. With the continued expansion in the use of turf for recreational purposes, there will be many more vew varieties, some better, some no different, available to the consuming public. It is more and more important to have evaluation trials throughout the area and to exchange experiences regarding adaptation, disease reaction, appearance, and persistence, if we are to select the best varieties for a particular area.

With the increased availability of specific named varieties adapted to specific conditions, we must be careful in purchasing seed to be sure that the seed sold actually represents a variety we wish to purchase. Certified seed is the most reliable guarantee of variety identity that is available in the United States. If the seed you buy is certified you can be sure it represents the variety stated on the label.

Let us consider first the bluegrasses adapted for turf use in eastern Washington. At the present time we can divide the several varieties currently available into two general types.

A. Merion-type Kentucky Bluegrasses. Here we would include Merion bluegrass, Newport bluegrass of which C_1 is generally considered a synonym, and perhaps Windsor. This group of bluegrasses readily forms a dense, fixed, low resistance of turf. They are bluegrasses with characteristically wide leaves, very vigorous rhozome formation, and are typically low growing. In eastern Washington they are well adapted for home lawns, golf course fairways, tees, and park use except under conditions of heavy shade.

B. The common-type Kentucky bluegrasses. Park, Delta, and many commercial selections that exhibit the typical tall growth of habit and somewhat open turf are characteristic of these bluegrasses. In contrast to the Merion types, these grasses are more erect growing, form a less dense and less wear-resistant turf, and, hence, to the discriminating turf user, are used only in areas where top quality is not a prerequisite.

A different species of bluegrass has been used, some in areas of intense shades such as the north side of buildings or under trees. This variety, rough stalk bluegrass, will tolerate reduced sunlight better than the common bluegrass varieties listed above, but in this condition of shade it is not wear resistant.

In eastern Washington, the only disease of importance that attacks the bluegrasses in these generalized turf areas at the present time appears to be leaf rust. Pathologists tell us that all of the known varieties are susceptible to this disease, although it appears to attack the variety Merion more readily in the field. This, perhaps, may be due to greater susceptibility in the Merion, or it may be due to the higher fertility level at which Merion is normally used. None of the varieties is resistant to the snow mold organisms that occur in eastern Washington.

Second in importance amongst the turfgrasses in eastern Washington are the fescue varieties. While there are several commercial varieties on the market and these are readily available, there is less difference among them than we see among the bluegrass varieties.

Varieties of creeping red fescue adapted to eastern Washington turf use include Pennlawn and Olds. Both these varieties are fine-leaved, drought-tolerant grasses, with somewhat more shade tolerance than the common bluegrasses. Although these two have short rhizomes, they do not spread as rapidly as the bluegrasses; hence they may not heal injuries to the turf as rapidly as will Merion or other bluegrasses. They are more tolerant than the bluegrasses to low light intensity. The tough, bristle-like leaves are highly wear resistant; hence they should be used where shade is a problem. These grasses germinate and emerge more rapidly than the bluegrasses; hence, for general purpose turf, a mixture of fescue and bluegrass is ideal.

Chewing fescue is a fine-leaved bunchgrass that does not spread to any extent vegetatively. When close-seeded for turf, it is very similar in appearance to creeping red varieties. Since it does not spread into flower beds or lawn borders to any extent, it is a popular lawn grass. Other fescues that are not well adapted to eastern Washington conditions include Illahee and Rainier. These varieties were developed in western Oregon and are adapted to conditions in Washington west of the Cascades.

Durar hard fescue is a relatively new variety of the fescue family that is being used for dry land turf where close mowing is not essential. On steep terrace banks, roadsides, and the like, this grass forms a very dense, tough, erosion-resistant sod. It can only be mowed with a sharp mower; hence it should not be used where close mowing is essential. Since it is drought resistant, it makes a very excellent grass for seeding golf course roughs.

None of the Bent grasses is adapted for general purpose turf use in eastern Washington. Their use should be restricted to golf course greens where they can be mowed daily, verticut, and aerified two or three times per year, fertilized regularly, and treated to control the various diseases to which they are susceptible. When used on lawns, they tend to form a thick mat or thatch after two or three years, and the lawn must then be torn up and reseeded. Likewise the various varieties of Bermuda grass and Zoysia are not adapted to eastern Washington. They are very susceptible to winter injury in this area, they lose their color with the first frost in the fall, and they do not green up until well after the last frost in the spring.

The following seed mixtures are recommended for various uses in eastern Washington:

A. School lawns, playfields, and city parks--Merion Kentucky bluegrass, creeping red fescue, 50-50 mixture.

Merion Kentucky bluegrass.	50%
Creeping Red Fescue	50%

B. Football fields--Sod with Merion Kentucky bluegrass sod or seed to--Merion Kentucky

Merion Kentucky Bluegrass	50%
Creeping Red Fescue	50%

If seed is used, the field must have six months of growing weather prior to its use.

C. Home lawns Merion-type Kentucky bluegrass or Merion-type Kentucky bluegrass plus creeping Red Fescue 50-50 mixture.

Turf areas that are intensively used should be fertilized according to soil test results for potash and phosphorus. They should have at least four pounds of available nitrogen per season.

VARIETIES, CHARACTERISTICS, AND ADAPTATION

Dr. Norman Goetze
Oregon State University
Corvallis, Oregon

The choice of a variety of turfgrass is dependent upon several factors. The climate and soils on which this grass is to be grown, of course, delineates rather large environmental areas. The use to which the grass is to be puts further limitation on the varieties within these areas. A third factor, of course, is the level of management which these grasses are to receive. We have had a rather intensive turfgrass variety and mixture testing program in Oregon, and it is my purpose here to review some of the preliminary results that we are getting from this study.

We have broken the state of Oregon's climate down into two broad categories; that of East and West. We treat western Oregon as a unit and use the Cascade mountains as a dividing line. We definitely include the Rogue River Valley in eastern Oregon and all of the Willamette Valley as western Oregon. The exact role of the Umpqua River Valley centered in Roseburg is not really known. We sometimes can treat it either way. This discussion will revolve around the characteristics and adaptations of varieties of these two broad climatic zones.

Each of the grass varieties can probably be best considered on the basis of its intended use. For putting greens and bowling greens, we have found Seaside bentgrass to be much preferred over Astoria or Highland varieties of Colonial bent. Under intensive management schedules, the Seaside bent provides less thatch and responds better to the close frequent mowing schedules much better than Astoria or Highland. Some experiences with Penncross bentgrass have been rather disappointing. Penncross bentgrass is resistant to some diseases which we are not much concerned about in the state, and there are no real advantages to this variety. Some of the golf courses have reported that its aggressive growing habits tend to create a puffiness or a thatch condition when properly fertilized; consequently, we are not recommending it for golf course green use. There seems to be little difference between eastern and western Oregon as far as putting greens are concerned. We have been recommending Seaside bentgrass throughout the state for green use.

For golf course tees, we have been very well pleased with Merion bluegrass in eastern Oregon because of its upright growth habit, its strong rhizome system, and its good resistance to light wear when properly managed. We have not been able to keep Merion bluegrass on tees in western Oregon; consequently, we have been preferring Astoria or Highland bentgrass. Some of the operators have been seriously considering a possibility of using Merion bluegrass on the tees in western Oregon, coupled with a resodding program every two or three years.

Golf course fairways require grasses which respond to minimum amounts of management, yet need to recover from rather serious divot and traffic wear. In western Oregon, regardless of what we plant on the fairways, they ultimately become bentgrass. We are suggesting Highland or Astoria bentgrass. Some of the new construction areas are using mixtures of the creeping red fescues and Highland bentgrass. The creeping red fescues provide a playable turf more quickly than straight Highland bentgrass, and if the rough and fairway are planted in one operation the fescues survive a little bit better in the shady portions of the rough. We sometimes prefer Highland over Astoria for the fairway because it does not require as much careful watering and it recovers from temporary drought periods much better than fairways in western Oregon. In eastern Oregon, I think we have had the best success with common Kentucky bluegrass or mixtures of common Kentucky bluegrass and the creeping red fescues. Little advantage has been seen in using named varieties of common Kentucky bluegrass for fairway use when we are practicing minimum maintenance in eastern Oregon conditions.

Most of the home lawns in western Oregon contain high percentages of bentgrass. Some homeowners are attempting to establish bluegrass lawns, but most of them become contaminated with wild strains of bentgrass over a period of from three to five years. Consequently, we have not been recommending bluegrasses for western Oregon, but have been suggesting either straight stands of bentgrass or mixtures using 75 per cent or more by weight of creeping red fescue varieties and Colonial bentgrasses. The fesuces provide good early establishment and remain in the dense shade a little bit better than the bentgrasses. Varietal differences within the creeping red fescue group have been very small. In other words, any of the varieties of creeping red fescue essentially are the same as far as western Oregon conditions are concerned. For home lawns, which are to receive good management, we prefer the creeping red fescue over Chewing's fescue. Straight fescue lawns in western Oregon have not been to satisfactory, because, when the creeping red fescues are weakened by red thread, we often develop rather messy-looking patches of bentgrass. If we plant some bentgrass in the fescue, we most often avoid this patchiness effect. As far as the Colonial bentgrass varieties are concerned, we prefer the Astoria bentgrass along the coastal areas of western Oregon and in the Valley areas on lawns which are to receive excellent water management. For lawns which are to be watered only periodically we prefer the Highland bentgrass. We use these variety designations because by just specifying Colonial bentgrass one usually gets either Astoria or Highland, whichever happens to be the most economical at the moment.

For eastern Oregon lawns, we are most enthusiastic about the bluegrass varieties. For lawns receiving only a minimum amount of care, the common Kentucky bluegrass has been most satisfactory. For lawns receiving extra amounts of nitrogen fertility and a good watering program, Merion bluegrass has proven very satisfactory. Without additional amounts of nitrogen fertility, however, it is actually inferior to common Kentucky because of its susceptibility to rust and other disease organisms. It, of course, has been very resistant to Helmenthosporium, which is quite serious on some strains of common Kentucky bluegrass. Special mention should be made of Newport Kentucky bluegrass for its excellence of performance in the more high-temperature regions in southern parts of Oregon. In some locations, it has actually been superior to Merion Kentucky bluegrass. Mixtures of bluegrasses and creeping red fescues have been very successful in eastern Oregon, but have not really been superior to straight bluegrass lawns. There is no place for any bentgrass varieties in eastern Oregon for home lawns. In fact, we would like to see more attention given in making absolutely sure that there is no bent contamination in seed lots being used for lawns in the eastern Oregon regions.

For athletic areas and other uses involving intensive mechanical wear, we are most enthusiastic about Alta fescue because of its tough resistant nature. Alta fescue is adapted to an extremely wide range of soil pH. It is very drought-tolerant, deep-rooted, and makes good late fall and early spring growth. It must be mowed at least two inches in height, preferably maybe even as high as three inches. It is a slow starter during the seedling year, and it has a poor rhizome system. Consequently, it must be planted at rates as high as from five to ten pounds per 1, 000 square feet to avoid clumpiness. If areas of football fields receive severe damage, they must be periodically overseeded to maintain Alta's density. We are recommending it for use throughout the state of Oregon for areas receiving the most intensive wear conditions. In eastern Oregon, many people are mixing the common Kentucky bluegrass with it. The bluegrass tends to fill in the areas that have been damaged, and we get a more uniform turf if it is not too intensively used. On the intramural areas and areas receiving only a minimum amount of wear, straight common Kentucky bluegrass is satisfactory in eastern Oregon. We see no place for Merion Kentucky bluegrass for these areas because of its higher maintenance requirements. In western Oregon, many people are mixing creeping red fescue with Alta fescue to get a more fine-textured turf. There is no place for bentgrass in any part of the state on areas receiving intensive mechanical damage. We have recently observed that S-23 perennial ryegrass is just about as resistant to mechanical wear as Alta fescue and is much more quickly established. We have had several rather successful plantings of S-23 ryegrass and Alta fescue on areas where they wanted to use the turf for heavy mechanical wear in less than one year after planting.

Summarizing the individual grass species by variety characteristics is as follows:

BENTGRASSES

Highland--dark blue in color, strong creeping habit, fair drought resistance, requires close frequent mowing.

Astoria--weaker creeping habit, light green in color, poor drought resistance, fine texture.

Seaside--requires close mowing, poor drought resistance, strong creeping habit, used only for putting greens and bowling greens.

Penncross--fairly resistant to brown patch, very aggressive, requires frequent thatch control on putting greens.

Vegetative selections have not been sufficiently tested in Oregon conditions to warrant any conclusions at this time.

BLUEGRASSES

Merion--resistant to Helminthosporium leaf spot, requires high amounts of nitrogen fertility, and is quite susceptible to rust.

Newport--fairly resistant to rust, susceptible to Helminthosporium leaf spot, and tolerates higher temperatures much better than Merion.

Poa trivialis--excellent shade tolerance, light green in color, non-erect type of growth habit.

Varieties such as Delta, Park, C-1, and experimental selections from private industry and other experiment stations are under test, but no con- differences under Oregon conditions have been found at this time.

FESCUES

Creeping red fescues generally are susceptible to red thread under western Oregon conditions and all have good shade tolerance. They are dark green in color and provide a dense turf. No consistent differences among Pennlawn, Illahee, Rainier, and common creeping red fescue have been observed.

Chewing's fescue--slightly more drought resistant than creeping red fescue; it is darker blue in color and is more difficult to mow.

Alta fescue--very wide-leafed, tough, drought-resistant, slowly established, well adapted to a wide range of pH conditions and makes good all-season growth.

SEEDLING MANAGEMENT

V. C. Brink
Plant Science Division
University of British Columbia
Vancouver, B. C.

"Accent the positive" is advice widely given, but today I am not going to heed it. My accent is on the negative.

Nine out of ten seedling management "problems" which come to my attention are best left to solve themselves. May I illustrate?

1. Often the very young stand of turf is weedy and weed control is requested. Herbicides are applied to, but, in my view, the seedlings are commonly more harmed than helped. In most instances the weeds are annuals and usually disappear with the institution of regular mowing. If the weeds are coarse perennial grasses, such as Velvet grass, often little can be done but to re-establish the stand on sterilized or weed-free soil.

2. Very often attempts are made to apply mineral fertilizers or other amendments such as peat to young seedlings. All too often the fertilizer "burns" the seedlings, whereas if left alone the "yellow areas" green up in a week or two as the seedlings gain a foothold. Peat and top-dressings applied to new seedings to "fill in" small gullies created by heavy rain or overwatering are best filled in after the turf is established.

3. Frequently a very young stand of grass looks uneven, or in places seedlings seem few and in other places thick. Usually, careful examination shows that even in the thin spots there are enough seedlings to make a good stand, and, given a few days or weeks, as the seedlings grow the bare spots disappear. Patience, not spot reseeding and raking, unless skillfully done, is often called for. Normally vastly more seedlings establish, several hundred millions per acre, than are needed for adequate cover.

4. I have rarely been able to apply fungicides to very young seedlings without damaging them. Dosages acceptable for established turf are often too heavy for seedling turf. Quite often I have been agreeably surprised at seedling comeback on untreated areas. Often a cutback on watering or a change in weather proved to give better control of minor epiphytotics.

Perhaps I have said enough to explain my view: "accent the negative in seedling management." As a seedling the grass plant is weak, and, very often, the less "management" or "manhandling" it receives, the better are its chances for survival and rapid establishment.

Another way to say my piece is to say that proper seed bed preparation and seeding practices obviate seedling management. Seedling problems, with few exceptions, arise when proper consideration is not given to seed mixtures, seeding time, seed bed preparation, weed control, soil fertility, and all the other preparations for germination. We are all something like the cowboy who pays 80 dollars for a hat, 100 bucks for a pair of boots, and $1.99 for his "levis." Sometimes we cut on some essential feature of seed-bed preparation, and we end up with a bare bottom.

I should not carry the negative accent too far. There are some things of special note for seedlings.

1. Under the long bright hours of sunshine in spring when the soil is cool and the air is dry and warm, desiccation of seedlings is a distinct hazard. Though soil moisture may seem adequate, sprinkling may be necessary.

2. A good-sized grass seedling is essential for winter survival of autumn-sown swards. If this cannot be achieved and the seeding is very late, heavier rates are recommended. We have demonstrated, repeatedly, under a variety of conditions, that dense seedling stands survive very much better than thin seedings; a continuous cover of grass, even if it is made up of very young seedlings, moderates soil surface temperature changes significantly.

3. The time to start mowing newly established turf is a matter of uncertainty. Also, there is uncertainty about the height of the first cuttings.

The rule of thumb that fescues and bluegrasses should be allowed to grow to 2"-2$\frac{1}{2}$" before cutting and that bents should be allowed to grow to 1$\frac{1}{4}$"-1$\frac{1}{2}$" is probably as good a rule as any. More important is the height of the first cuttings; preferably the first cut should be high and cutting height gradually reduced in succeeding cuttings to the desired level. About 1" below the first cutting is the rule for the final cutting.

Of course, it is important to allow the seed bed to firm up before cutting, but excessive growth is distinctly harmful. Under our conditions, seedlings developing in warm cloudy weather seem to be very vulnerable to damage by close clipping. We have tried, but not very successfully, to associate the the vulnerability with low carbohydrate food reserves in root and stem.

FUNDAMENTALS OF ARCHITECTURE IN RELATION TO TURF MANAGEMENT

A. V. Macan
Golf Architect
Victoria, B. C.

There is a strange misconception about bunkers, viz., that they are designed to punish bad shots. They are primarily designed to increase the interest in the playing of the game. Poor players pay the bills like the low-handicap players, but poor players not only dislike being in bunkers but slow the pace of the course and increase the time it takes all players behind them to play their round. The more poor players there are, the slower the pace of the green.

Bunkers from the tee should be so far away that poor players cannot reach them. Ben Hogan goes so far as to suggest 10 per cent of this game is played with your clubs, 90 per cent with your head. If, for instance, a poor player finishes in a bunker 240 yards from the tee with his SECOND shot, I suggest it is his head not his swing which requires examination.

The more penal your course (Pine Valley is possibly the supreme sample of a penal course), the more certain it is that weaker players will score badly. How some of them get around at all is hard to understand; perhaps their entertainment is pride in membership in so famous a club or maybe the members are none of them rabbits.

There is an unquestioned tendency today to develop super courses which only the professor can play, and some of them cannot do that. I note that in 1961 when Littler won at Oakland Hills, a few traps were filled in that existed in 1950 when Hogan with a superb final round won the open. Seemingly, it was deemed too tough even for the professors.

I hope and believe this phase will pass, and golf architects will more carefully observe such a course as the Masters of Augusta where the immortal Bob Jones and the late Alister Mckenzie set out to develop a course suitable for the enjoyment of the club members and, when needed, a superb, and exciting test of the best of players.

QUESTIONS AND ANSWERS FROM THE PANEL ON THE FUNDAMENTALS OF ESTABLISHMENT OF TURFGRASSES

QUESTION:

Whenever grass reaches the height that you want to maintain it, should it be mowed that soon after seeding? Has there been a change in the thinking that this is not so?

ANSWER: (Dr. Brink)

Certainly the bents do not come up to the upright growth habits as do the fescues. I do not think we are too far off in our recommendations on that, and certainly these grasses should be mowed by the time they are six weeks old.

QUESTION: (Bill Bengeyfield)

Can you condemn a grass for being too aggressive?

ANSWER: (Dr. Goetze)

Actually, in the case of Penn-Cross it does a very good job for us except when we start spending too much time getting rid of excess thatch. If you want to make this treatment of extra vigorous growth a part of our program, then Penn-Cross is probably the best grass for us. But I think we are going to end up spending more time in management and wearing out Bob Wiley's machines than taking care of this problem.

(Comment from Bob Wiley)

I feel that the mechanical elimination of thatch of Penn-Cross is not altogether the only answer. We also need to use a different type of top dressing program.

QUESTION: Do you think that a municipal course should be a series of traps?

ANSWER: (A. V. Macan)

No I do not. With the quality of player that you find on municipal courses, it takes them long enough to get around the course as it is without handicaping them with a series of traps.

QUESTION: How do you control small patches of bent in bluegrass lawns?

ANSWER: (Dr. Norman Goetze)

For the control of this bentgrass in bluegrass in western Washington and Oregon, we can do it with chemicals; but most of these are too detrimental to other plants.

PANEL DISCUSSION OF TURFGRASS MANAGEMENT BUDGETS

Paul D. Brown, Moderator
G. A. Drew
Henry W. Land, Jr.

Introduction

Paul D. Brown, Moderator
Seattle, Washington

Our panel consists of three persons, myself (Paul Brown), Mr. Graham Drew, University of British Columbia, Vancouver, B. C., and Mr. Henry Land, Jr. of the Sand Point Golf and Country Club, Seattle.

As an introduction, I would like to put forth a couple of questions. Why have a budget? Is it good or bad?

First, a budget is a preplanned program for the length of time called for, generally a year. If planning ahead is a good thing, then a budget is good. If a superintendent works on a hit-or-miss, day-by-day manner, a budget will do him no good. The better a superintendent can plan ahead, the better he will be able to manage his turf.

Second, the drawing up of a workable budget takes real thinking and arriving at decisions. A good budget will include a thorough knowledge of working conditions and labor management. It will portray a picture of the equipment, its age, conditions, and depreciation. It will determine the purchase of materials such as fertilizer, herbicides, seed, sprinklers, and all materials either pertaining to golf, cemetery, park, recreation, or industrial types of turf and landscaping.

Third, it will itemize the proposed cost and outlay of every phase of operation. It will determine the number of man-hours for each season and department of labor. It will approximate the cost of fertilizer, lime, seed, tools, and equipment. It will show cause for new equipment and depreciation of old equipment.

So much for the budget.

The next thing is how you determine the budget. This must be covered by income. There is no justification for a budget that cannot be met equally by revenue. Somewhere down the line, this porposed budget will be scrutinized. It may be the State Legislature, the County or City Commissioner, the Park Board, the Board of Directors, or the Greens Committee. This is where you will need the utmost confidence in your ability to manage or supervise your operation. And, when it is once approved, it will tend to elevate your position as a good superintendent.

Yes, a budget is a good thing if it has a good superintendent to back it up and to abide by every detail and item proclaimed within it.

We shall proceed, then, with the rest of our panel and hear from Mr. Drew and Mr. Land, Jr.

SOME ASPECTS OF PUBLIC RELATIONS

G. A. Drew
Department of University Extension
University of British Columbia
Vancouver, B. C.

It is interesting that in this age of astronauts and satellites and push-button conveniences, we must continue to talk about our public or human relations. The necessity to communicate, particularly on an individual basis, has been with us since the beginning of mankind. And yet in many respects this seemingly simple act of communicating with one another becomes increasingly difficult as more and more technological subjects, each with its own tongue-twisting terminology, are heaped upon us to be read or listened to and understand.

The manufacturers are constantly urging us to buy a vast array of new products which have evolved out of these technological advances. Whether we need them or not is incidental. To do the job, the advertising world employs communication specialists and psychologists to advise it of our subconscious likes and dislikes. The resulting messages about products thus persuade the unsuspecting consumer to buy this brand instead of that brand, and that to be up to date he should not be seen with anything less than such and such a model, or that the new larger package outshines them all.

By now you must be wondering what all this has to do with the topic at hand. The thoughts which I have been leading up to are: firstly, that in a broad sense it is becoming more and more difficult to communicate with one another and be sure that we are understood. Secondly, that special consideration is being given to the art or science of attracting people's attention and influencing their behavior. Let me elaborate these points as they apply to your position as superintendents.

We all know that there is a tremendous amount of scientific research and technology as well as practical know-how behind the production and maintenance of good turf. All of you, in varying degrees, will be familiar with this specialized knowledge. It is this familiarity which could be a danger point, not only at budget time but at all times in your association with club members. I believe it can be safely assumed that not all aspects of your duties as superintendents will be completely understood by the green committee with which you must work. The wise superintendent will realize this and make special efforts to explain adequately each detail which appears on the budget sheet. Only in this way can a sympathetic understanding be expected, particularly if new expenditures are being budgeted for. To do this will require accurate record-keeping on a continual basis every day of every week of every month of every year. Only in this way can the superintendent hope to have at his fingertips all the information which may be required at any given time. It is often necessary to draw comparisons from the experiences of other years; here again are essential. To rely upon memory alone is poor practice and can certainly not be condoned. Information such as total area of greens, cost of renovating fairways, amounts and dates of fertilizer applications, and the like is not only important to the superintendent but of interest to the general club membership. You will do much to enhance your relations if you make a practice of divulging some of this information when the opportunity presents itself. In addition, if you have the means or can readily devise them, it would be to your advantage to consider communicating in the visual sense. This can be done through the well-known newsletter or by appropriately worded photographs showing any new work which you may have accomplished. The before-and-after type of treatment would be particularly effective. Let us not forget that the golf course is the most important part of the entire operation, and anything which can be done to inform the membership of everything concerned with its maintenance will be that much better in creating an awareness of your requirements. I am told that a number of people quite often join golf clubs simply for the social aspects. If this is the case, it seems doubly important that you pay particular attention to this aspect of membership relations just mentioned.

Much more could be said about the points mentioned so far; indeed, books have been written about some of them. This leads me to my next point which I consider to be extremely important. If you find yourself lacking in the ability to express yourself or do not understand the fundamentals of keeping records, then the onus is on you to take the necessary steps to correct this situation. Most educational organizations, whether it be university, school board, Y. M. C. A., or others, give evening classes in subjects such as these, and there is seldom an excuse for not taking advantage of them.

At this point, I should explain a difficulty which I encountered in the preparation of these remarks. There is obviously a great difference between the duties and responsibilities of some superintendents in the United States and most of those in B. C. --certainly in the Vancouver area. I was surprised to learn of the responsibilities which many of them do not have and in my estimation should have. For instance, some superintendents, I learn, do not present a prepared budget to the green chairman. In more than one instance, I found that establishing the annual budget was merely a matter of sitting down with the chairman (often at his calling) and chatting about the things that would be undertaken in the coming year. I expect that someone was taking notes, but it was not the superintendent. Variations in procedure in the differing cases of public and private courses is understandable, but it seems fundamental that a written statement should be prepared by and put in the hands of the superintendent in almost all cases. Unless this is done, it is easy to imagine what could happen if one of the aforementioned influential social set were to become elected as green chairman. Failure to do this could indicate a certain degree of lack of interest on the part of a superintendent, and thereby detract from the esteem with which he could be regarded.

While I have assumed that my colleagues on this panel will have covered the many and varied aspects of a budget, I would like to make reference to one particular item which is of considerable importance. Unfortunately, this remark is more appropriate to the people who are not here and who seldom attend such functions as this. You people will recognize the importance of attending conferences and other educational functions dealing with your particular interest and requirements, and I would urge you to continue to give this budget item priority rating. Supplemented with reading pertinent to your work and continuous exchange of information amongst yourselves, you will be doing the utmost to keep yourself fully informed and thereby be in a better position to improve your public relations in the manner which has been indicated.

Much has been written and said about the subject of public relations, and I am sure most of you will be as familiar with it as I. In the final analysis, we do not need to concern ourselves about the scientific approach mentioned earlier. The subtle, somewhat high-pressure methods may be necessary in big business, but for our purpose the old-fashioned way of doing things will bring more results.

Let yourself become known for such attributes as sincerity, understanding, and genuine interest, and public relations will take care of itself.

In conclusion and at the risk of offending some of you I would like to mention one more point. Tied up with all the elements to be considered in public relations is the matter of personal appearance. Do you remember this point being driven home to you in your early school years? It is hardly necessary to do more than mention the fact that a neat appearance creates a good impression, and, conversely, a sloppy one has the reverse effect. Carrying this further, I would extend the statement to include your equipment, sheds, and offices. When was the last time you took stock of your surroundings and decided to spruce them up? Again this may seem far removed from the subject of budgets, but I'll steadfastly maintain that it has a bearing, however remote, on the respect and prestige with which the superintendent is held, which in turn will determine his effectiveness in presenting the annual budget.

GOLF COURSE BUDGETS

Henry W. Land, Jr.
Superintendent, Sand Point Golf and Country Club

There are many different methods of preparing a budget. These are best illustrated by six different articles on budgets published in the Golf Course Reporter, November and December, 1961. Two other good sources of information are the U. S. G. A. Greens Section which has a publication entitled, "A Guide For Green Committee Chairman," and the other is Turf Management by H. B. Musser. Certainly there is enough information in these publications to aid anyone in preparing a budget.

Comparisons of budgets with any degree of accuracy are very difficult, if not impossible. Many of the reasons for this difficulty were pointed out by Mr. Milt Bauman of the Overlake Golf and Country Club at the annual meeting between club officials and golf course superintendents. Some of the reasons that were pointed out were related to differences of location, terrain, soils, total amount of acreage, trees, sand traps, types of grasses, different accounting systems, and many other contributing factors.

By keeping the above in mind, I would like to show some slides on surveys that have been conducted.

SOUTHERN CALIFORNIA GOLF ASSOCIATION
GOLF COURSE OPERATING COSTS
OF 29 GOLF COURSES
PRELIMINARY REPORT--1960

	Payroll Costs	Supplies	Maintenance	Water	Miscellaneous	Total
Low	$ 42,100	$ 4,820	$ 1,668	$ 2,126	$ 246	
High	108,814	29,090	18,641	15,956	15,967	
Average	68,900	13,249	6,248	10,248	2,136	$100,817
%	68.4	13.1	6.2	10.2	2.1	100%

SURVEY CONDUCTED BY
THE PACIFIC NORTHWEST GOLF ASSOCIATION 1961

Taken from a fifty page report
Thirty-eight Golf Clubs participating

CLASS A CLUBS
Dues Excess of $108, 000

	No. Clubs Reporting	Annual Expense - 18 Holes		
		High	Low	Average
Superintendent--with Lodging	2	$ 5, 340	$ 4, 260	$ 4, 800
Superintendent--without Lodging	9	8, 400	6, 600	7, 377
Laborers	8	43, 247	20, 392	33, 287
Sand, Soil, Chemicals, Fertilizers, Seed and Supplies	10	7, 848	687	7, 456
Gas, Oil and Grease	9	2, 238	217	1, 281
New Equipment Purchased	8	7, 042	600	3, 016
Equipment Repairs	10	3, 206	900	2, 273
Course Alterations and Landscaping	8	45, 000	1, 200	13, 060
Water and Power	8	2, 935	600	1, 613
Other Expenses	6	18, 000	1, 500	6, 007
TOTAL EXPENSES	10	$109, 072	$19, 442	$59, 056

CLASS B CLUBS
Dues From $60, 000 to $108, 000

	No. Clubs Reporting	Annual Expense - 18 Holes High	Low	Average
Superintendent--with Lodging	3	$ 7, 200	$ 5, 400	$ 6, 400
Superintendent--without Lodging	10	8, 160	4, 500	6, 213
Laborers	12	40, 294	8, 620	22, 056
Sand, Soil, Chemicals, Fertilizers, Seed, and Supplies	12	9, 533	1, 336	3, 356
Gas, Oil, and Grease	10	1, 197	525	872
New Equipment Purchased	11	9, 914	1, 756	4, 581
Equipment Repairs	11	2, 720	602	1, 809
Course Alterations and Landscaping	5	6, 841	750	2, 531
Water and Power	10	5, 455	900	2, 552
Other Expenses	8	6, 000	382	2, 358
TOTAL EXPENSES	12	$67, 446	$22, 640	$42, 845

CLASS C CLUBS
Dues Less Than $60, 000

	No. Clubs Reporting	Annual Expense - 18 Holes High	Low	Average
Superintendent--with Lodging	3	$ 6, 000	$ 3, 000	$ 4, 500
Superintendent--without Lodging	10	6, 600	2, 200	5, 110
Laborers	11	18, 000	200	12, 895
Sand, Soil, Chemicals, Fertilizers, Seed, and Supplies	9	3, 219	175	1, 937
Gas, Oil, and Grease	9	2, 715	200	918
New Equipment Purchased	5	2, 730	50	1, 269
Equipment Repairs	8	5, 997	100	1, 728
Course Alterations and Landscaping	2	1, 100	600	850
Water and Power	9	3, 300	64	1, 442
Other Expenses	4	4, 752	122	1, 863
TOTAL EXPENSES	9	$33, 754	$4, 366	$24, 769

Conclusions

These reports show the rapid increase in operational costs of golf clubs over the past few years. This has resulted in some clubs changing over to general managers in hopes of curbing this rapid increase. In most cases, this has not directly affected the golf course operation except the appropriation of necessary funds.

Many clubs have set up special committees to make a careful study of funds needed in every department before making appropriations. They also study methods of raising these funds to support an adequate budget.

In many cases one can use the services of local or national groups to help point out the need for increases in operating funds to cope with problems on the golf course. Sometimes this can be very helpful in accomplishing better golfing conditions for your members. Sometimes people just can't see or understand the problem, but when it is presented by someone different, it is quite often readily accepted.

PANEL DISCUSSION OF FUNDAMENTALS OF MANAGEMENT

Dr. Norman Goetze
Arden W. Jacklin
Dr. Roy L. Goss
Donald A. Hogan
Bob Wiley
Glen Proctor

VARIETIES AND MOWING

Dr. Norman Goetze
Oregon State Univeristy
Corvallis, Oregon

Mowing of turfgrass varieties is influenced by the use intended for the grass, the intensity of the management, and the climate and soils of the region. Generally speaking, we note that frequency of mowing is also related to height. When a grass plant is mowed frequently, its meristematic region or growing point is elevated on the stem. To protect that area, we must, therefore, mow at a higher height than if it were mowed more frequently. Destruction of the growing point lowers the turf density by causing the grass to reinitiate new growing points from the crown instead of the existing stem. To maintain those dense turfs desired by most people, we must protect the meristematic regions by our mowing cycles.

The bentgrasses have the lowest requirements in mowing heights, and for most desirable bentgrass turf, we must now mow it more frequently.

Most satisfactory stands of bluegrass turf are obtained by mowing heights of 1-1/2 to 2-1/2 inches. The fundamental reason for this high mowing height is not thoroughly understood. Some people suspect that it is related to the development of horizontal leaf growth at the higher mower heights, resulting in a greater photosynthetic area. This is an interesting area of turfgrass research which has not yet been fully explored.

The fine-leafed fescues are not very critical in their mowing height requirements. The alta fescue must be mowed at least two inches in height, preferably maybe even three inches. At the lower heights, it develops a very weak root system, and it loses its good resistance to mechanical wear.

We need to be more cognizant of the basic physiological reactions of an individual grass plant and how the management schedules that we impose upon it influence its growth and development. A grass plant does not react because of any deliberate thought process, but instead reacts to internal and external influences. The better we can understand these reactions, the better we can cope with some of its problems.

The grass plant derives its energy from exposure of the leaves to the sunlight through a process called photosynthesis. Every time we defoliate the grass plant by mowing or other treatment, we reduce that photosynthetic area. The grass plant is respiring or using energy throughout the 24-hour period. Excess energy created during the daytime is stored in the root zone.

If we completely defoliate the grass plant, the initiation of new growth occurs at the expense of root reserves in the earlier photosynthetic activity. Consequently, mowing schedules must be established which will leave some photosynthetic area for the replenishment of root reserves. If complete defoliation is used, it must be used infrequently so that root reserves are not entirely depleted. More fundamental work is needed in this phase of management.

MAINTENANCE FERTILIZATION

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Corvallis, Oregon

In addition to the usual environmental variables including climate, soils, type of grass, and the use being made of the grass, the level of maintenance fertilization is also dependent upon the objectives of the maintenance program. There are basically three approaches used in fertilization of lawn grasses. The first involves a minimum amount of maintenance in which we are involved in merely keeping the grass alive with a minimum expenditure. The second level of maintenance involves getting the absolute maximum utilization of all management factors, including fertilization. This level of maintenance is that which is most often practiced in commercial agriculture, in which we are concerned with the most efficient fertilizer use. The third and highest level of maintenance is getting absolutely the highest quality of turf at any cost of maintenance. We oftentimes term this luxury consumption. Here we are concerned with the maximum amounts of fertilizer that can be used without any damage to the turf.

The philosophy of fertilization is different for each of these three levels of maintenance. Many of the conflicts in recommendations and practices on turfgrass fertilization can be resolved if we recognize these differences in levels of maintenance.

Instead of developing a uniform set of recommendations for turfgrass fertilization, let's take a look at some of the factors which influence the effectiveness of each of the fertilizer elements.

Nitrogen

Larger quantities of nitrogen fertilizer are required on turf than any of the other fertilizer elements. Much of the nitrogen used in turf fertilization, however, is wasted and never becomes available to the turfgrass plant. Nitrogen can be lost from turfgrass by several different methods. A process called denitrification accounts for minor losses from the surface of the turf when excess amounts are applied and are left on the surface. In this process, the nitrogen-containing compounds are broken down into elemental nitrogen gas, which is in turn released to the atmosphere.

A very similar process called ammonification also accounts for some surface losses. In this case, the nitrogen fertilizer materials are converted into gaseous ammonia giving the very characteristic odor. These losses are quite small, except when heavier amounts of nitrogen fertilizer are used.

Leaching of the nitrogen fertilizers by excessive rains or heavy irrigations accounts for a very high degree of loss of nitrogen fertilizer. The more soluble forms, such as the nitrates and urea, are especially susceptible to this type of loss.

Turfgrass clippings contain from 3 to 6 per cent nitrogen on an air-dry basis. Removal of the clippings throughout the season can therefore account for a considerable loss of nitrogen from the turfgrass area. Leaving the clippings on the turf, however, does not give us much fertilizer stimulation. Much of the nitrogen that is in the clippings is never made available to the turfgrass roots again, because the clippings do not completely decay.

A good share of the grass clippings and the older roots remains intact in the soil as organic matter. The organic matter content of many of the older turf soils may be as high as 8 or 10 per cent. Some of the new turf soils contain as little as 2 or 3 per cent organic matter. Through the years the accumulation of organic matter accounts for copious quantities of nitrogen. Soil organic matter has a carbon-nitrogen ratio of about 10:1. Thus, when we are raising the organic matter content of a soil weighing 2, 000, 000 pounds per acre by 1 per cent, we are actually adding 20, 000 pounds of organic matter. Since this organic matter has a nitrogen content of about 10 per cent, we are effectively tying up one ton of actual nitrogen per acre, just to raise the organic matter content by 1 per cent.

Nitrogen that is not lost from the turf soil by any of the previous procedures is therefore available to the plant. Nitrogen acts as a stimulation to growth. If excessive amounts are made available to the plant, excessive growth results in a decreased plant food reserve, which ultimately can damage the root system. Grass tissue that is growing excessively fast may also be more susceptible to certain fungus diseases.

The most sensible nitrogen fertilization program involves use of types of fertilizer that will minimize the potential losses and yet make only small amounts of nitrogen available to the plant at any one time.

Phosphorus

Phosphorus behaves in turf soils altogether differently than nitrogen. It is not converted into volatile forms which can evaporate from the surface, and it is likewise very difficult to be leached. It is very effectively kept from the turfgrass plant roots by being tied up with the soil colloid system. The phosphorus becomes attached to the soil particles with more strength than the plant can exert in absorbing the phosphorus.

Additional amounts of phosphorus may never become available to turfgrass plants because the phosphorus moves so poorly through the soil and accumulates on the surface. The phosphorus content of turfgrass clippings is very low, and depletion of phosphorus reserves is not influenced by disposal of the clippings.

Under low levels of nitrogen fertilization, it is very difficult to demonstrate any phosphorus response on turf beyond the seedling year. At the upper levels of turfgrass maintenance fertilization, a phosphorus response can be demonstrated.

Of more importance than the absolute amount of phosphorus used is the ratio of nitrogen to phosphorus.

Potassium

Large quantities of potassium exist in most turfgrass soils, and, under minimum levels of fertility, there are sufficient quantities of this element for the turfgrass. Potassium is very readily leached from soils, but additional quantities of potassium are constantly being made available by the decomposition of the basic material from which our soils are derived. Organic soils and some sands are very low in potassium. Some potassium is also tied up in the base change complex of soils.

Under higher levels of maintenance, potassium may be limited in better-quality turf. This has been demonstrated repeatedly on some of the older putting greens throughout the country, which have been receiving higher levels of nitrogen and phosphorus fertility over a long period of time. When excessive growth is stimulated through the addition of nitrogen fertilizer, the potassium may be removed through the clippings at a faster rate than is being accounted for by the decomposition of the basic minerals in that soil. Under those conditions, it is easy to demonstrate a potassium response.

Large quantities of potassium can be removed through the turfgrass clippings, since the turfgrass plant is not able to exclude excessive amounts of potassium. The plant absorbs these extra amounts through a process called luxury consumption. The exact amounts of potassium to be used in maintenance fertilization have not been clearly defined by good experimental work to date.

Sulfur

This element has never received much attention in turfgrass fertilization research, but in certain regions of the Pacific Northwest sulfur has shown to be limiting.

Sulfur is very similar to nitrogen in its processes of loss from turfgrass soils. The inorganic forms of sulfur are very readily leached, and the organic forms behave in exactly the same way as nitrogen. It can also be removed by the clippings, but the sulfur content is much lower than the nitrogen content. 16-20 fertilizer has been very popular in the western regions of the Pacific Northwest for a long period of time. Many workers have thought that this was due to the phosphorus content. Many of the soils in those areas are deficient in sulfur, and the sulfur content of the 16-20 was sufficient to give a good turf response. Critical research on the exact needs of turfgrass plants is completely lacking. Until such results are available, use of sulfur-containing fertilizers, especially on the western slopes of the Pacific Northwest, is strongly recommended.

Iron

Turfgrass workers have been way ahead of workers in almost all other economic crops in their recognition of the role of iron for most efficient production. We have been especially cognizant of the role of iron, because it serves as a part of the chlorophyll molecule. This material, as you know, imparts the desirable green color to turfgrass. There are large quantities of iron in almost all types of soil. Most of it, however, is not available to the plant roots, because it is either closely tied up with the soil minerals, or is in such a form that the plant cannot absorb it. Additions of small amounts of available forms of iron to the soil usually are not very effective in improving the turfgrass, because the iron, too, becomes attached to the soil minerals or is converted to forms that are not available to the plant roots.

Iron is most efficiently used by foliar applications of extremely small amounts. Iron is not very readily stored in grass plants, and if it is applied to the foliage, frequent applications are necessary for the desired effect.

Other Materials

Calcium, magnesium, boron, copper, cobalt, molybdenum, zinc, and manganese are also required for turfgrass plants. Very little research has been done on their use, and they need not be covered in this discussion.

TURF MANAGEMENT - MAINTENANCE FERTILIZATION

Arden W. Jacklin
Jacklin Seed Company
Dishman, Washington

I am approaching maintenance fertilization of turf primarily from a home owner's viewpoint. The principles involved, however, apply to turfs in general.

What are we looking for when we fertilize--why fertilize?

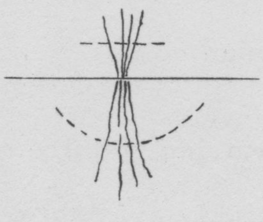
If the average home turf manager could prescribe or dictate just what he wanted from his lawn, with or without fertilizer, he would likely come up with about this lineup: 1. deep or sharp green color, 2. good density, 3. a minimum of mowing--just enough growth to renew the grass from wear spots, damage, etc., and 4. less frequent or a minimum water requirement. Let's call these our objectives.

Can we come near to giving him what he wants? Let's see.

How can we, or do we, get color? Right here I will lead with my chin. I differ quite definitely with many recommendations and, may I add, many technical recommendations.

The quick and easy way to get color and, for a time, the cheapest way, is with quickly available, high-nitrogen-content chemical or, more properly said, inorganic fertilizer. For the home owner lawn manager I do not agree that this is a good recommendation. Why?

Let's start out with grass roots and tops. A grass plant's top and root are always pretty much in balance. Now what does this mean to us? Simply, it means that if we have four inches of top growth the roots are pretty much balanced with that top growth. So if we cut off the top two inches of top growth we cut off one-half, and the root system moves quickly to come into balance with the reduced top by shedding one-half of its feeding root system. Right here is the crux of our problem. The one-half of the root system that is shed is the outer periphery of the system. As grass roots are mostly down, this means that the shedding is roughly the lower one-half of the total system.



Now any practice that stimulates rapid top growth--which quickly available chemical nitrogen does if applied in quantity sufficient to promote our green growth objective--inevitably causes frequent mowing off of high percentages of top growth with accompanying root losses. Roots don't grow back as quickly as upright top growth under high nitrogen availability, so we get even shallower root systems and less soil depth to supply fertility and moisture; sprinkling requirements go up; more nitrogen is needed to maintain color; and we are on the merry-go-round with each application of quickly available or hot-shot chemical nitrogen aggravating the situation.

Now let's look at sodding--remember our numbers 2 and 3 objectives--more grass, deep carpet, and density.

High level of available nitrogen in soils retards sodding of sod-forming grasses. Low level of available nitrogen in the soil--down around minimum growth requirements--promotes sodding.

In our Kentucky bluegrass seed fields, by controlling available nitrogen levels in the soil, particularly in the fall when sodding is most vigorous, we have demonstrated time and again that we can take a good, bunch-type Kentucky bluegrass stand--starve it for nitrogen--and it will sod in solid. We can take a thickly sodded Kentucky bluegrass stand and make it grow into a bunch-type stand with a high level of nitrogen.

Agronomists have known the principle involved for some time in treating so-called "sod binding." Fertilize with nitrogen at good, high rates to overcome "sod binding." Ripping up or mechanically thinning the stand is not the answer.

This same relationship of nitrogen to sodding holds true in lawn. Additionally, we know that a high level of available nitrogen promotes upright top growth. Fast growth and upright growth are simply the result of competition for light. Rapid growth is upright, elongated growth. Elongated growth means long-leaf sheaths. Long-leaf sheaths mean that the leaves are high up from the crown, or, to say it another way, the leaf canopy is high. Anything other than very-high-mowing height cuts deeply into the canopy, and total leaf surface is reduced, as well as leaving a stubby, shingled-looking growth. So, no matter how we approach the effect of rapid growth we come up with the same result.

High-level available soil nitrogen results in low density--it's just that simple. Mowing deeply into top growth results in shallow root systems. Shallow root systems result in more frequent watering being necessary. More frequent watering, in the Spokane area at least, results in creeping bentgrass invasion, by far our most serious home lawn problem.

Overgrow grass--get into trouble. Milk soil nutrients out of the soil by stimulating growth and activity of soil microbiological life with hot-shot nitrogen--something's going to run out and become limiting.

Now let's go back to our objectives.

1. Deep or sharp green color.
2. Good density.
3. A minimum of mowing
4. Less frequent watering requirement.

Can we attain them with quickly available, chemical nitrogen from high-analysis fertilizer? I think not, with the well-being of the home owner's turf in mind.

So let's start over, beginning with our number 1 objective--color.

We know that the nitrogen route is one way--to a point and with time limits.

Now, we're talking about grass color. What is color? Chlorophyll and chloroplasts. What is chlorophyll? In extreme simplicity, it's interrelated iron and magnesium ions surrounded by nitrogen, carbon, hydrogen and carbon, and hydrogen oxygen and carbon. Other trace minerals are present in chloroplasts which are other colored parts present in addition to chlorophyll.

We've come a long way in learning how to handle iron on our turfs for color--chlorophyll. But other trace minerals are also involved. Iron substitution alone for displacing or making available other traces in the base exchange system isn't the whole answer. It's part of it, but the total answer is with complete feeding balanced out with the soil's abilities to supply each and every element. The use of minor or trace elements combined with judicious feeding of a balanced nutrient formula for color is the alternative to the straight nitrogen route.

So much for color.

Now let's look at objectives 2, 3, and 4--good density with a minimum top growth so we don't have to mow too much and too deeply and still have a maximum depth of root system so we can water with least frequency.

Right here I must go back and point out that I gave only a part of the picture when I drew the picture of mowing. I did it to make my point without confusion on the effect on the root system of deep mowing on fast-growing top growth. Actually, we <u>can</u> have a deep root system without tall top growth, because the relationship of top to root in turf grass is between the <u>total leaf</u> surface--not height alone--and the root system.

So a low-growing, low-crown, dense, heavily leaved top growth will balance out with a heavy deep root system if we can attain that kind of top growth. Can we? Sure we can if we don't go hot-shot nitrogen happy. Here, then, is the place for natural, slow-releasing organic nitrogen sources giving even, low-level nitrogen feeding to the turf. Here, also, is where the synthesized, slow-releasing ureaforms are finding their place.

I have purposely avoided phosphorous potassium and other fertility elements in this discussion. There is no question about their need and value in turf feeding. I believe in and sell balanced formula fertilizers. Ratios will vary with varying soils and climates. However, it is not my purpose to discuss these here. My purpose is to leave with you my opinion regarding balanced formula, low-level nitrogen feeding versus quickly available, high nitrogen content, chemical fertilization. We must exercise care and judgment in our recommendations to the home lawn manager. It's easy to do him a disservice with a recommendation spectacular in its early performance but harmful in the long run.

FERTILITY EFFECTS ON DISEASE DEVELOPMENT

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Western Washington Experiment Station
Puyallup, Washington

A great amount of work has been done over the past several years with the turfgrass diseases. A considerable amount of knowledge has been gained on the effect of fertilizers and other factors on disease development.

In recent years, work has been conducted through the Western Washington Experiment Station at Puyallup, and papers have been published regarding the control of Fusarium Patch caused by the fungus Fusarium nivale (1). One of the studies incorporated into this experiment on the control of Fusarium Patch was the effect of fertilizers, both intensity and ratio, upon the development of this disease. The results of these studies indicated that the level of nitrogen applications as well as the source of nitrogen could greatly influence the amount of disease development. In all cases the higher levels of nitrogen caused much more Fusarium development.

In these experiments it was also observed that when nitrogen was obtained from urea that more disease developed than when other sources of nitrogen were used. Likewise some of the organic source nitrogenous materials increased the amount of Fusarium development during the early fall.

The Effect of Fertility on Ophiobolus Patch (Ophiobolus graminis)

The fungus Ophiobolus graminis causing the disease Ophiobolus Patch was first identified in Washington in November, 1960 (2). Even though the disease was previously reported in England, it has not been a serious problem elsewhere in the United States according to literature.

In fertilizer plots at the Western Washington Experiment Station, a variable intensity of Ophiobolus development was observed within the different fertilizer treatments. A closer watch was kept thereafter on the diseased area to determine what possible effects nitrogen, phosphorus, and potassium could have upon the development of this disease.

Effects of Fertility on Ophiobolus Patch Development

Plot No. and Fertilizer Treatment	Disease Ratings[1] January '62	September '62
1. 20-0-0	4	7
2. 20-4-0	5	6
3. 20-4-4	6	6
4. 20-4-8	4	6
5. 0-0-0	0	1
6. 20-0-4	4	5
7. 20-0-8	5	5
8. 12-0-0	3	2
9. 12-0-4	2	2
10. 12-0-4	3	2
11. 12-4-0	2	2
12. 12-4-4	2	1
13. 12-4-8	3	0
14. 6-0-0	1	3
15. 6-0-4	0	0
16. 6-0-8	0	0
17. 6-4-0	1	0
18. 6-4-4	0	1
19. 6-4-8	2	2

[1]Disease rated in Ophiobolus Patch caused by Ophiobolus gramis. Ratings are from 1-10. A rating of 10 is severe, more than 40 per cent of the plot being infected.

From the table above it is obvious that the amount of nitrogen applied is the important factor in this case. Perhaps the source of nitrogen is just as important; however, source experiments have not been conducted at this time. The source of nitrogen in these experiments is from urea alone. Urea is being used since all fertilizer applications on these plots with the exception of phosphorus go on as spray treatments.

As the rate of nitrogen application decreases so does the amount of infected or diseased area. When this disease first appeared it was even more pronounced on the higher-fertilized plots. However, as time progresses the disease seems to become more generally widespread.

Fertility Effects on Red Thread (Corticimun fuciforme) Development

In trials conducted at Puyallup for two years, it has been shown that higher rates of nitrogen serve as good control measures for red thread during the growing season. Since this disease causes a leaf tip burning or browning effect, subsequent growth and removal of infected parts by clipping produces a desirable appearance. Nitrogen will produce this growth effect as long as other elements are present in sufficient amounts.

This does not imply that no fungicidal or other controls are necessary, since the disease can become serious at times in the fall even on well-fertilized turf. However, a good fertilization program is important throughout the growing season.

Conclusions

There are no definite conclusions from these studies at this time. An experiment is being set up currently to study Ophiobolus Patch in more detail. However, from two years of observation we can generally conclude that the higher the amount of nitrogen the greater the infection from Ophiobolus Patch will be, particularly in the early stages of development. At this time there seems to be little interaction between phosphorus and potassium with nitrogen on the incidence of this disease; however, these factors will be investigated more thoroughly in the future.

One interesting observation during the summer of 1962 has been the occurrence of white mold in certain plots throughout the fertilizer experiment. This white mold is believed to be caused by a Basidiomycete. Some problems of a rather serious nature are occurring along with this disease. These areas seem to be puffing more and are being scalped by the mower. Recovery is generally quite slow. The treatments affected worse in this case are numbers 10, 12, 13, 15, 16, and 18. It may be concluded here again that nutrition may be a factor in the development of this particular problem.

1. Gould, C. J., Goss, R. L., and Miller, V. L. "Fungicidal Tests For The Control Of Fusarium Patch Disease Of Turf." Plant Disease Reporter 45:2, February, 1962.

2. Gould, C. J., Goss, R. L., and Eglitis, Maksis. "Ophiobolus Patch Disease of Turf in Western Washington." Plant Disease Reporter 45:4 April, 1961.

TURFGRASS IRRIGATION

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We are all aware of the need for irrigation. It would seem that our primary concern is, therefore, the cost--initial, operating, and efficiency. Naturally, all of our planning and operation is predicted on available water supply.

One can scarcely discuss this subject today without immediately becoming aware of the need for some type of automatic control of our irrigation system. Since we have talked about the fundamentals of sprinkler distribution previously, I shall confine most of my remarks to the aspect of permanent-type installations and automatic controls.

There is no doubt that the best sprinkler irrigation can be achieved with the proper pattern of relatively short-range sprinklers. This is because a better penetration of thatch plus acceptance of the moisture by the soil will result with smaller droplet size which is indicative of the smaller-diameter sprinklers. In addition, the closer spacing of the shorter-range sprinklers is less distorted by wind effect, and a minimum of overspray in areas not desired to be watered will result. Therefore, we have digressed from long-range, single-line patterns to multirow coverage.

Certainly we are cognizant of the continual increase in labor cost plus the difficulty in obtaining water men on a seasonal basis with nighttime operation. Turfgrass areas used for golf courses, athletic fields, and parks are receiving more utilization, minimizing the time available for maintenance. Also, the competition in the cemetery field makes it necessary to do less maintenance, including watering during the daylight hours.

Solutions to these problems can best be reached with the installation of a permanent irrigation system with some type of automatic control. The control can vary in degree to the condition of the areas involved. This means that the system can be designed with a range of control whereby a relatively great number of sprinklers will operate simultaneously in the same area or divided in control to where each individual sprinkler is controlled separately. For example, an entire fairway on a golf course or a complete section of a cemetery or a park might operate through a single control valve or be divided into smaller groups of sprinklers, possibly ten, a half dozen, two or three, and finally to each single sprinkler. There are many factors that influence this choice in design such as topography, water availability, first cost, type of area, and soils, too numerous to discuss in detail in this paper. Generally speaking, however, the more finite control will give better results of irrigation and higher efficiency of watering.

When considering the installation of a fully automatic system with rotary pop-up sprinklers, we must recognize that there is a practical limit as to range (diameter) of the sprinkler and precipitation rate. Experience has shown that precipitation rates in excess of approximately 3/10 of an inch an hour will not satisfactorily penetrate turf and thatch so as properly to distribute to the soil. Therefore, in the case of most sprinklers on the market, a maximum diameter of 100 to 110 feet should be used with a maximum spacing between sprinklers of approximately 70 to 75 feet for no wind condition. Sprinklers of larger size in this category generally will yield too great a precipitation rate for most turfgrass areas.

In the event a semi-automatic system is desired, sprinklers of the above-ground, agricultural-impact type used in conjunction with quick-coupling valves can be utilized at a longer range and greater spacing than the rotary pop-up sprinkler. Here diameters up to 130 feet with spacings to 90 feet can be used and still maintain satisfactory droplet size and precipitation rates when operating at the proper water pressure.

One must be particularly careful when using part-circle sprinklers on automatic sprinkler systems. To achieve the same radius as full-cycle sprinklers, most rotary pop-up sprinklers require the same gallonage for the part-cycle sprinklers. Therefore, if 180^{o} or arc is selected, the precipitation rate would be twice the rate of the full-circle sprinkler and should not be operated the same length of time and by a control valve that is also operating full-circle sprinklers. The best solution is to have the part-circle sprinklers grouped separately. The single nozzle of an agricultural part-circle sprinkler for semi-automatic use is not quite so critical in ratio of gallonage to radius between part- and full-circle operation. However, it is still desirable, and best results can be had by separating these sprinklers in control.

The amount of water required to grow turf adequately varies appreciably due to conditions of temperature, humidity, type of soil, type of grass, wind conditions, and many other factors. Many agronomists will determine that this range is from approximately 1.0 inches per week to 2.2 inches per week, depending on the area where the turf exists. I believe that satisfactory turf can be maintained on less water, provided a high degree of efficiency in application is reached. Experience has shown that for areas of temperature in the range of 70 to 80^{o}, only about 0.75 inches is required per week. Similarly, in the 80 to 90^{o} range about 1.0 to 1.2, and in the 90 to 100^{o} range about 1.5 to 1.7 has proven adequate. However, an additional safety factor should be added when designing a system.

Automatic control can be a decided asset in the efficiency of water distribution. Exact amounts can be applied without the element of human error. Therefore, a minimum amount of water can be applied up to the needs of the turf without overwatering. Another decided advantage, particularly in tight soils, is that during a given scheduled watering period the application to any area may be proportioned whereby a small amount is applied first to break the surface tension, and then the entire amount of water application can be divided into a number of cycles to eliminate runoff and ponding.

Frequency of application is also a topic of many variables and considerations. Generally, it is best to water infrequently on a given area with a maximum applied during each irrigation period. This amount is determined by the ability of the soil to retain the moisture within a desired depth of root zone. For the same soil conditions, warm, dry-climate grasses may be watered much more infrequently than cool, moist-climate grasses that tend to develop a shallow root structure. Once-a-week application for deep-rooted turf for fairways, cemeteries, parks, and playfields has proven adequate. However, for the shallow-rooted grasses at least two applications per week are necessary. Closely cut putting surfaces with a minimum of thatch cover may require more frequent application. Some superintendents water their putting greens very heavily on Mondays, and augment with lesser applications during the rest of the week.

In closing, I would like to emphasize that often the irrigation maintenance is treated too lightly, which not only inhibits turf growth but aggravates other turf problems. Therefore, irrigation of turfgrass areas should receive as much attention as any other phase of turf maintenance.

AERIFICATION--PRINCIPLES AND PURPOSE

Bob Wiley
Aero-Thatch Inc.
Rahway, N. J.

Sometime--centuries ago--aerification by application of a tool took place when primitive man observed that breaking the soil surface aided plant growth and produced a greater food yield. No doubt this cultivation of the soil was performed with pointed sticks and sharp stones. Very primitive, very inefficient, but effective. Not only was it effective, but it marked the inception of the evolution of agriculture and specifically soil cultivation which is my subject at this time.

As the methods of soil tilling were developed and improved and more complete and rapid pulverization of the soil resulted, it became an assumed conclusion that surface disintegration was one object--in fact--maybe the prime intent of cultivation. Whether this is truly beneficial in all ways is questioned by some research men. Certainly we in turfgrass culture know that the drastic effects of complete surface pulverizing are only an extreme and last resort in the solution of our problems. We would all like to have the beneficial effects of tilling out turf soil if they could be obtained with no serious surface damage. It would appear nearly hopeless to look for a method of cultivation worth the time, expense, and effort, and then expect no appreciable turf surface injury. However, the indomitable spirit of the men familiar with the problems present in managing turfgrass under pressure has driven them to search for this paradoxical procedure.

The primitive sticks and sharp stones of the historic researchers have in our field their counterparts. Early turf-cultivation tools were slow, back-breaking devices to puncture the surface. Square-tined forks, pointed steel rods, nail-studded boards, spiked rollers--all man powered--were used to make holes, to puncture, so that air and water could enter the soil.

From this elementary beginning grew the concept that turf cultivation was practically limited to hole or silt punching, and was followed, as mechanization of turf culture developed, by a number of more or less effective hole- or slit-punching devices, most of which have served well within their limitations.

The implements which were developed for aerification were varied and interesting.

As early refinement of these tools, although still man powered, was the English tapered, hollow-tine fork brought here by Walter Totty of Echo Lake Country Club, Westfield, N. J. This tool, which set the pattern for later machines with respect to hole cutting or punching, cut and lifted a core out of the soil.

Although the following comments may not be all inclusive nor may the order of mention be strictly chronological with respect to the implements mentioned, nevertheless the recent history of aerification is generally as follows.

Following the English hollow-tine fork and the type-spike-tooth disc, which is in common use today, came the Turferator. This was an excellent piece of equipment. It consisted of a set of small soil augers which drilled holes through the turf into the soil below. The result was fine but the process slow.

The Night Crawler was quite similar, except that it punched holes with hollow tines rather than drilling them. This was a cumbersome machine and slow.

The most widely accepted of all the aerification equipment was the West Point Aerifier whose principle was a greatly improved version of the hollow tine. Undoubtedly there are more West Point machines on golf courses today than any other make, although in recent years the Ryan Greensaire has been making headway in the turfgrass field.

There is one common denominator in all of these machines. They are designed to aerate by making holes; generally speaking, these machines all puncture the soil in one way or another. None of these machines cultivates, and with the severe compaction factors of today, namely, heavy traffic, frequent mowing, and weighty machinery, cultivation without surface damage is the great need. Obviously aerification alone falls short of the complete need of loosening the soil.

We all know the definition of soil compaction and have experienced or observed it in fine turfgrass areas. We have seen the soil structure so altered that water could not percolate, air had been forced out, root growth was greatly impeded, and the turfgrasses dwindled away to nothing. The real need at this point is cultivation. Since soil activity and plant growth decrease as compaction increases, it follows that plant growth will improve as compaction decreases and soil activity is restored, all other factors being favorable. Soil puncturing has done much to satisfy aeration needs but little to relieve compaction. There must be better ways to improve soil structure than by perforating.

Thatch

Thatch, an accumulation of organic matter (leaves, stems, and roots), as it becomes greater in depth and density has an effect on the movement of water and air into the soil below. We may liken dense thatch to a poorly managed compost pile, and in so doing see more clearly the necessity for keeping it under control. When we make a compost pile, the object is to convert undecomposed organic matter into decomposed, healthy humus and humus soil by encouraging the microbial activities by which conversion is brought about. Moisture and air in sufficient quantities are necessary to supply the micropopulation so it may live and multiply to feed upon and convert this undecomposed organic matter into useful material.

Aeration equipment can and does contribute to thatch control. The degree to which it contributes is governed by the principle employed. The hollow-tine type of equipment removes a quantity of thatch with each plug of soil removed. However, the quantity is small in relation to the amount present. The spoon-type equipment, being somewhat similar in action and principle to the hollow tine, removes more but still a relatively small quantity. The spike-disc machine removes no thatch and will only puncture the surface. These punctures close quickly, so again water and air movement is restricted.

Microrotary cultivation, as accomplished by the saw-tooth-type equipment, displaces thatch from a cultivated groove in a continuous manner throughout the area.

Layers

Any turfgrass area which has received a top-dressing of poorly prepared material, an application of sand and/or humus, or of a single top-dressing substance may and often does have a layer of this material which restricts the movement of water and air into the soil below. In turn this inhibits root growth below the layer. Aeration machines play an important part in relieving this condition and improving it by puncturing or, even better, by cutting continuous grooves through it.

In summation I would say that it appears that aeration of turfgrass areas which are used for recreational purposes in a necessary practice. The purpose should be to maintain and in some cases to restore soil sturcture so that the movement of water and air is not restricted, to control the accumulation of thatch, and to relieve the effects of layers where they exist.

The type of equipment employed to accomplish this will remain a matter of choice of the individual. However, it is safe to say that soil cultivation which goes beyond mere soil puncturing must be the goal of the turfgrass industry.

TOP-DRESSING PUTTING GREENS

Glen Proctor
Rainier Golf and Country Club
Seattle, Washington

Through the years that I have been a golf course superintendent, I have been carrying on a top-dressing program. In my thinking there have been many mistakes made in top-dressing.

During the 1930's we depended on our compost top-dressing as part of the fertilizer program. Most of the compost top-dressing is built up from barnyard manure. If you had a contract with a farmer for the barnyard manure, you were quite fortunate. This barnyard manure was mixed with what we thought was the proper soil, generally adding lime and superphosphate, some nitrogen, and a little potash. This was a pretty expensive procedure. During 1935 and 1936 most of the golf clubs were paying common labor on the golf courses $35 a month. The cost even with this cheap labor was about six to seven dollars per yard by the time the compost had been turned three or four times and screened. In those days soil was generally free for the finding.

The results from this type of top-dressing were good provided that the soils used in the compost were of the right composition and matched those of the putting greens where the compost was to be used. My personal thinking is that a good many of our problems today such as layered greens were caused by the wrong mixture of soils in the top-dressing. Actually, if it were not for smoothing the surface of the putting green, we would be better if we had never used any top-dressing. So in looking back over the mistakes we have made in the past, maybe we should include poor top-dressing programs as one of them.

At one time top-dressing with sand was almost a standard procedure with a lot of superintendents. Research throughout the nation has proven this to be the worst thing to do.

Today with modern aerifiers the picture has been changed somewhat. With the hollow-tine aerifiers you can leave the plugs on the green, put on soil additives, and also include lime. Following this treatment, put a verticut over the green to chew up the plugs and mat them in. This will give a satisfactory job of top-dressing without any change in soil, other than the additives put on with the plugs before verticutting.

Again, be careful about what you are adding to the aerifier plugs. Add straight sand, and you will get in trouble because it will separate and again you are building more problems.

QUESTIONS AND ANSWERS FROM THE SECTION ON THE FUNDAMENTALS OF MANAGEMENT

QUESTION: (George Harrison)

Is there any particular time on any of these particular elements when its application would give any different results?

ANSWER: (Dr. Goetze)

There is a lot of argument about that. Some people say that because phosphorous does not move readily through the soil that is better to apply it in the fall or winter so that it will have a chance to get into the root zone. Actually, so far as we know now, no one knows just when it would be best to add some of these nutrients.

QUESTION:

After aerifying and bringing the plugs to the surface, should a person fill these holes up, just leave them open, or try to rub back in the material that came out?

ANSWER: (Bob Wiley)

After getting information on the type of turf, size of spoons on the aerifier, etc., I get into more arguments on this subject, but I don't think it's possible to fill all of those holes back up with any material, whether you rub back in the material you brought up or whether you apply new material. I think that eventually they will fill up with one thing or another, and I don't think I would be too concerned about it. This is particularly so on a cemetery, which is your problem.

PANEL DISCUSSION ON PREPARING A GOLF COURSE FOR TOURNAMENT PLAY

Dick Haskell
Director of Municipal Golf for the City of Seattle

and

John Zoller
Golf Course Superintendent for the Eugene Country Club
Eugene, Oregon

To answer this broad question, we must first ask the scope of the tournament. Is it national, regional, or local? Each of these types of tournaments demands a different type of treatment. In the last 27 years in the Pacific Northwest, we have had 13 tournaments that would qualify as national in scope. We will deal with some of the following in some detail:

1. 1935 USGA public Links Championship, Eastmoreland Golf Course, Portland, Ore.

2. 1937 USGA Amateur, Alderwood Country Club, Portland, Ore.

3. 1947 PGA, Manito Country Club, Spokane, Wash.

4. 1952 USGA Amateur, Seattle Golf Club, Seattle, Wash.

5. 1953 USGA Public Links Championship, West Seattle Golf Course, Seattle, Wash.

6. 1955 Ryder Cup Matches (England vs. U. S. A.) Portland Golf Club, Portland, Ore.

7. 1958 Canadian Open, Point Grey Country Club, Vancouver, B. C., Canada.

8. 1960 NCAA (Intercollegiate) Championship, Eugene Country Club Eugene, Ore.

9. 1961 USGA Women's Amateur, Tacoma Country and Golf Club, Tacoma, Wash.

10. 1961 USGA Junior Girls, Broadmoor Golf Club, Seattle, Wash.

11. 1961 Walker Cup Matches (England vs. U. S. A.), Seattle Golf Club, Seattle, Wash.

12. 1961 PGA Tour Tournaments, Broadmoor Golf Club, Seattle and Columbia-Edge Water Golf Club, Portland, Ore.

13. LPGA Tour Tournaments, Rainier Golf and Country Club, Seattle, and Esmeralda Golf Club, Spokane, Wash.

Some of the tournaments in the Pacific Northwest that are strictly regional in scope are: (1) 1960 Western Amateur, Waverly Golf Course, Portland, Oregon, (2) The annual PNGA Amateur Championships in Seattle, Portland, Spokane, Vancouver, and Victoria, and (3) state opens and amateurs at various locations.

The following outline will help to determine the preparations necessary:

1. Practice fairways and pitching greens.
2. Practice putting greens.
3. Course tees (longer and shorter length).
4. Fairways(wider or narrower--50 yards is standard width.
5. Greens.
6. Hazards.
7. Additional parking.
8. Additional clubhouse work (comfort stations and sanikans).
9. Additional equipment needed (flagsticks and markers).
10. Additional cost: (who bears it?).
11. Course on day of play:
    a. Hole cutting (who spots?)
    b. Placing tee markers.
    c. Local rules to be observed?

One example of appropriating a practice fairway was evident in the 1953 public links at West Seattle Golf Course. There was no practice fairway available, so Pete Masterson, then Director of Golf for the City of Seattle, obtained the use of the adjoining football field and baseball field for ten days' practice use. The over-all length was about 250 yards--just about long enough for some wood practice. The big problem was to keep the young boys and girls off this area during this ten-day period. These kids had been so used to having free run of the field--it was quite a patrolling problem to keep the kids from being hit by flying golf balls. We haven't been able to find an instance where a pitching green was constructed just for tournament use.

In 1952 at the USGA Amateur at Seattle Golf Club, it was reported that special use had to be made of the 17th and 18th fairways for additional practice use. This presented quite a problem in the afternoon when these fairways were being used by the matches that went that far. In 1961 at the USGA Women's Amateur at Tacoma Country and Golf Club, the practice fairway adjoined the 10th and 18th fairways. Whenever matches were proceeding down the 10th and up the 18th fairway, anyone practicing on the side of the 18th (and the 10th on the left) had to hold up. There were more than a few cases where the player's ball got mixed up with the many practice balls. The ideal practice set-up is like Waverly Country Club, Portland, or Fircrest in Tacoma, where the practice fairway does not parallel any course fairway.

In the case of practice putting greens the USGA recommends that the contour and surface, as closely as possible, resemble the course putting greens. The same height of cut should be used as on the course.

The building of new course tees is much in evidence when preparing for a national tournament. At West Seattle in the 1953 USGA Public Links eight new tees were constructed just for this particular tournament. In each case the course was made longer; however this isn't always the case. In Tacoma for the 1961 USGA Women's Amateur the tournament committee asked that the 5th hole be shortened from 240 yards to 180 yards (250 yards is an odd length for women). The superintendent, Henry Land, Sr., built a 2,000-square-foot tee, and it is now used exclusively for the women of the club. I'm sure the women have thanked Henry Land many times for this shortening.

In the case of putting greens, the USGA recommends that the height of cut be in the vicinity of 7/32 to 3/16 inch. This, of course, will vary, depending on whether the surfaces can take this low cut. Much is said on how firm or soft these greens should be. In some cases it has been recommended that all putting-green watering be suspended for the duration of the tournament. These steps can be too drastic in the opinion of the maintaining superintendent (hot weather). He has to account to the members for the course the rest of the year. The height of the collar is about 1/2 to 3/4 inch. This normally extends for about five feet. The next area, extending about six feet, is to be cut at about two-inch height. This "frog's hair" region is one of the most controversial topics in golfing circles. Too often a shot just barely off the green is severely penalized--whereas a more erratic shot is not properly penalized.

Comment from the floor: Ken Putnam, superintendent of the Seattle Golf Club, stated that his golf club was not going to accept any future national tournaments that required any altering of the course as the members play it. Ken stated that all this additional cost is borne by the club. There was a question raised as to the sanity of such requests.

We have seen several cases where new hazards have been constructed just for certain tournaments. In some cases these additional hazards have been removed after the tournament is over. Of course, such construction is rather expensive for use for just a six-day tournament. It would seem that additional hazards should be constructed with future use in mind. There should be an improvement in the course to justify any large expenditure.

The problems of providing sufficient parking for large golf tournaments are with us. The Seattle Open at Broadmoor in 1961 and 1962 has made great use of the University of Washington football parking lot with a shuttle bus running to and from the golf course. This has worked out very well at a fee of $1.00 round trip. This shuttle bus idea is a must for a club with parking facilities like broadmoor.

The additional clubhouse work usually involves the movement of the members out of their lockers for the period of the tournament. There is the usual moaning, but this doesn't last long. In the larger tournaments it is necessary to install several portable comfort stations (sanikans). The location of the food concessions is important. Wear and tear on turf should be considered.

It is recommended that an extra set of flagsticks and tee markers be available in case of pilferage.

On the day of play of the tournament, it is the sole responsibility of the committee to locate the cutting of the holes. This same committee does the positioning of the tee markers. All local rules should be spelled out in detail. It is often difficult for the tournament player to adjust to certain local rules. The use of lime around certain questionable areas has been accepted. No matter how much care the superintendent takes, there are going to be a few missed spots. Since this is especially so in stroke competitions, it is recommended that the holes not be changed in the course of play for the whole day.

Whenever the hole becomes damaged, changing is then justified. If rain should make the hole unplayable, this would be justification for moving the hole; however, whenever possible, this should be anticipated and holes cut on higher ground.

In summary, it would be safe to say that golf course superintendents do not favor altering their courses just for tournament use. Too, it is hard to imagine that the superintendent would have his course in better shape for tournament than he would have for the members (who ultimately pay the bill). This "better for a tournament" is fast becoming a myth; however, this is bordering on the philosophy of why we hold tournaments. It has been said that tournaments are the only ways we can test the prowess of the players. Does this prowess need testing?

John and I would like to thank the USGA for the use of its Tournament Manual and Ken Putnam, Glen Proctor, Henry Land, Sr., and A. V. Macan for their sage remarks in helping prepare this presentation.

PANEL DISCUSSION ON FUNDAMENTALS OF TURFGRASS DISEASE AND INSECT OCCURRENCE

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You probably feel that turfgrasses have much more than their due share of diseases, and you are probably correct. There is much more likelihood for an accumulation of undesirable organisms in perennial crops such as grasses than in ones such as potatoes which are harvested every year and with which crop rotation can be employed. However, it is much easier to assess the damage for the latter. Incidentally, losses from plant diseases in these and other crops are heavy--about three billion dollars on the average each year for all crops in the United States.

But what is the dollar value of an unsightly lawn hit by Red Thread? How does one estimate the loss from Fusarium spots which develop on a green just prior to a tournament? Perhaps we could use a percentage of the annual maintenance cost. According to recent studies in California, this cost for all turf averages about $20 per person per year. On this basis we obtain a figure of $3.6 billion for the United States. However, the installation cost is about three times as high, so we are actually speaking here of an industry with a ten-billion-dollar capital investment. Therefore, anything that affects it is bound to be important. Since this field is becoming more and more technical, it is appropriate today to review certain basic aspects of turfgrass diseases.

Our science of phyto-patho-logy (from the Greek meaning: plant-disease-study) is only 100 years old, but many of the known diseases are much older. Rusts, blights, and mildews are mentioned in the Bible. The Romans thought that gods were responsible for diseases, and they even had a god for rusts to whom they offered sacrifices whenever it appeared necessary. Fairy Ring is another old-time problem. The mushrooms were suppose to appear where fairies had danced the night before. Too much sap was the cause of some other diseases, according to different people.

In 1845 and 1846 a disastrous failure of the potato crop occurred which resulted in the real beginning of our science. Potatoes, the major food of Ireland and much of Europe, were devastated by blight disease. In Ireland alone over one million people died and another 1½ million emigrated. What could cause such a tragedy? DeBary, a great scientist in Germany, proved that a fungus was the cause of this disease in potatoes.

Where do the organisms come from that cause such havoc? In many cases, they have moved along with their host plants from their original homes. In other cases they have "jumped" from native diseased plants to new cultivated hosts. Many organisms also mutate, or change, so new strains arise--some of which may be able to affect previously resistant varieties.

What Is a Disease?

We could give you a hundred different answers to this, but a good simple definition is a "deviation from normal." The factors causing disease may be roughly grouped as follows:

Nonparasitic or physiological--smog, sulfur dioxide fumes, sunburn, waterlogging, nutrient deficiencies and excesses, etc.

Parasitic higher plants--such as mistletoe and dodder.

Nematodes--small roundworms. Their importance in turf in Washington hasn't as yet been fully determined.

Viruses--Infectious agents too small to be seen with the usual (light-type) microscope. Not thought to be a problem in grasses used for turf. Viruses cause tobacco mosaic, yellow dwarf of barley, mumps in man, etc.

Bacteria--one-celled microscopic organisms that reproduce by dividing and do not have definite nuclei. They may divide every 20 minutes. They cause such common diseases as crown gall and fire blight, but are not yet a problem in turfgrasses.

Fungi--low forms of plant life that lack chlorophyll and reproduce by seedlike bodies called spores. They usually produce masses of strands (hyphae) which, grouped together, are called mycelia. There are about 40,000 different types of fungi, of which at least 750 occur on grasses. Almost all of our turf diseases are caused by this group of organisms. The major types are as follows:

A. Phycomycetes (water molds)--hyphae usually without cross walls. Spores often swimming. Cause Damping off and Pythium blight of grasses. Late blight of potatoes and downy mildews on peas are examples of diseases caused by these fungi on other crops.

B. Basidiomycetes--spores formed on a club or basidium. In this group are included the rusts, smuts, and mushrooms. Fairy Ring, Red Thread, Brown Patch, and Typhula snow mold are grass diseases caused by Basidiomycetes.

C. Ascomycetes--spores formed in a sac or ascus, usually eight at a time. Sclerotinia Dollar Spot and Ophiobolus Patch are representative diseases on grasses. Peach leaf curl is one of many important diseases found on other hosts. Most ascomycetous fungi also produce nonsexual spores. In addition, there are other fungi for which no sexual spore stages are known. These (asexual) fungi fall into the next group.

D. Fungi Imperfecti--sometimes, as with the Fusarium Patch (Calonectria graminicola) fungus, we know that the sexual stage is an Ascomycete, but either we don't usually see it, or, because of custom, we continue calling the fungus by its imperfect name. Several other turf pathogens also are grouped here, including the Helminthosporium blight and Anthracnose fungi.

Not all bacteria and fungi are harmful. In fact, if it weren't for the role many of them play in rotting dead animals and plants, we wouldn't be here today. Some fungi are used for food (mushrooms); some produce antibiotics; many are symbiotic--on roots of peas, pines, and other plants. Millions of bacteria and thousands of fungus fragments can occur in one spoonful of soil from an ordinary lawn, and most of these are beneficial. If they were not present, the pathogenic types wouldn't have any competition and the disease loss would be teriffic.

Incidentally, if fungi attack living plants we call them parasites--but if they live only on dead material they are called saprophytes. Many of our turf pathogens can do both, either simultaneously or at different times of the year.

How Do We Name Fungi?

Many fungi have both scientific and common names. Scientific names are the same all over the world, while common names vary with language and locality. In order to avoid confusion, we usually use at least the genus name in our discussions. Fungi are named in much the same way as grasses are. For example, there are several types of bluegrasses. Each distinct type is a species--as annua for annual bluegrass and pratensis for Kentucky. But both are similar enough to be placed in the same genus--Poa in this case. Let's take Fusarium as an example of the fungi. There are many different species that attack grasses, but our most common one is called nivale. Others distinctly different are culmorum, avenaceum, etc. Since they resemble each other in certain key characteristics (as spore shape), they are grouped together under the genus Fusarium. Closely related genera are grouped into families, families into orders, and orders into classes. But for us the key words are the genus and species names, such as Fusarium nivale, Ophiobolus graminis, Corticium fuciforme, etc.

What Symptoms Do Fungi Cause?

We usually think of fungi in relation to dead grass. However, some fungi may cause a change in color, as the darker green grass associated with Fairy Ring. Others may stunt plants. Some produce galls--as certain types of rusts on trees. Others cause wilting, and, of course, many cause death directly or indirectly.

How Do Fungi Spread?

One method is by the spores mentioned earlier. Certain spores, as those of the Pythium blight fungus, can swim under their own power. Others (as with Fairy Ring) are forcibly shot into the air and then blown about by the wind. Spores of the Fusarium fungus may be dispersed by the splattering of raindrops or in irrigation water. Fortunately, most spores perish, since each fungus produces hundreds of thousands of spores. Only if they land on a suitable substrate and also have a suitable environment do they survive.

However, man and his machines are probably responsible for 90 per cent of the spreading of fungi in turfgrass. Diseased fragments are easily picked up, particularly on clubs, shoes, and especially on lawnmowers. This is particularly true of Fusarium-diseased pieces of leaves and the red mycelial strands of the Corticium fungus. Disease development in such cases is faster than with spores since a heavier reserve of food is present in the fragments. Still, diseased spots don't usually form overnight, despite what many people think. For instance, Fusarium nivale grows rather slowly at first, forming a $\frac{1}{4}$- to $\frac{1}{2}$-inch spot that is fairly well hidden by healthy overlapping grass blades. Then, with this area as a base, the fungus appears to "explode" during favorable weather. We have noticed on putting turf regularly treated with fungicides that the disease did not begin to reappear until six weeks or more after treatments had been discontinued, despite the presence of numerous infested areas only a few inches away. (It was unlikely that the fungicides provided residual protection for such a long period, since heavy rains probably washed away most of the material and the continued growth of grass supplied untreated surfaces.)

Conditions Favoring Infection

Just as with human beings, different fungi like different conditions. However, in general, infection occurs most readily when conditions are more unfavorable for the host than they are for the fungus. One of the most important of such factors is that of temperature. The Brown Patch fungus is, apparently, common in western Washington, but it causes trouble only during hot muggy weather, which rarely occurs. Typhula snow mold attacks only at temperatures near freezing in eastern Washington. Most of our serious parpsites prefer temperatures between these extremes. Although we have found strains of Fusarium that vary in their optimal temperatures, we believe that the main effect of temperature on this organism is an indirect one. Thus, under laboratory conditions, Fusarium nivale easily attacks bentgrass at 70° F., but outdoors we seldom find it occurring at this temperature. Why? Most likely because the grass is sufficiently dry during most of each day at this temperature to prevent fast growth of the fungus.

Fungus mycelium is so fragile that it dries easily. Therefore, external moisture is an absolute requirement for disease development. More moisture and slower grass growth are the main reasons for the serious disease outbreaks we usually get in the fall and less often in the spring.

Besides temperature, nutrition is another important factor affecting the susceptibility of the grass plants. Excessive nitrogen increases losses from Fusarium on bent, but inadequate nitrogen may also weaken the plants and make them more susceptible. High levels of nitrogen enable fescues to outgrow the Corticium, but we do not now believe that nitrogen necessarily induces resistance; instead it seems to keep the grass growing ahead of the fungus. The full effect of phosphate and potash have not yet been determined, but it is evident that they also have some influence. In general, it appears that all three elements are needed in the right proportion for greatest disease resistance.

pH--As the soil becomes more alkaline (as from applications of lime) attacks by both Ophiobolus and Fusarium increase in severity.

There are many other factors affecting disease development, including organic matter, soil texture, drainage, and light, but the ones discussed above appear to be most important.

However, we actually have very little accurate data on the full effect of these various factors on our turf pathogens. Until these are obtained, we are more or less "spraying in the dark." The best place to hit a parasite is at the weakest link in its life cycle. Until more basic information can be obtained, we don't know what the weakest link is and will, therefore, just have to continue "spraying along."

How Plant Diseases Are Controlled

Control is often classified under the following four headings:

Exclusion--i. e., an attempt to keep pathogens from being introduced. Our Federal Quarantine Service enforces many regulations aimed at excluding plant diseases from the United States. However, our most serious turf pathogens are so widely distributed in the Northwest that this possible approach is only of academic interest at the present time--at least for the diseases already here.

Eradication--is our main standby. This is essentially what we believe we are doing when we spray or drench diseased turf with PMA, Cadmium, etc. However, it usually is only a matter of minutes before the pathogen is reintroduced on shoes or on equipment. This explains the need for repeated spraying, as well as the desirability of spraying adjacent areas where fungi may be residing--as collars or shoulders around greens.

Protection--is a common control measure for such plants as roses, potatoes, and apples. However, we don't believe it is of much importance with turf since the grass grows so rapidly. If we ever get to the point of using growth retardants--which will keep grass from growing--we will have an entirely new disease picture and protective spraying might become a necessity.

Resistance--is often the last measure resorted to, but from the long-term viewpoint it is by far the best. It also usually takes the most effort and time to accomplish. Obtaining resistance in turfgrasses in the past has usually been incidental to the search for other desirable cultural characteristics. In order to achieve this goal, joint efforts between pathologists and agronomists are going to become more essential in the future. In western Washington, we have noticed that Penncross and certain strains of *Poa annua* are quite resistant to *Fusarium nivale*. Other grasses are resistant to Dollar Spot, rust, etc. You all know that Merion is more susceptible to rust than is Kentucky bluegrass, but, on the other hand, Merion is the more resistant of the two to *Helminthosporium* blight. These are just a few of the examples.

For western Washington we particularly need a suitable bent that is resistant to *Fusarium* and *Ophiobolus*, and a fescue that is resistant to *Corticium* (Red Thread).

Current Recommendations for Control

Our current recommendations are listed in Extension Mimeo 2049 available from your county agent.

Our turf disease research is conducted in cooperation with Roy L. Goss (Agronomist) and V. L. Miller (Chemist), with aid from state funds and grants from the Northwest Turf Association, U. S. G. A. Green Section, and California Chemical Corporation. To these groups we express our appreciation.

Terms

Since articles on turf diseases are becoming increasingly technical, we are listing below for your reference some of the terms often used. They are taken from the USDA Yearbook on Plant Diseases for 1953.

AGAR--A gelatinlike substance extracted from a seaweed.

ALTERNATE HOST--One of two kinds of plants upon which a parasite fungus must develop to complete its life cycle.

BACTERIUM--A one-celled, microscopic organism which is a low form of plant life.

CAUSAL ORGANISM--The organism that produces a given disease.

CHEMOTHERAPY (kem-o-ther-a-pee)--The treatment of disease by chemicals that work internally.

EPIPHYTOTIC (ep-i-fy-tot-ik)--The sudden and destructive development of a plant disease, usually involving an extensive area.

FRUITING BODY--A complex fungus structure that contains or bears spores and from which they are disseminated.

FUNGICIDE (fun-ji-side)--A chemical that kills or inhibits fungi. Bordeaux mixture, lime-sulfur, and ferbam are fungicides. (Also PMA and cadmium chloride.)

FUNGUS (fungus)--A low form of plant life which, lacking chlorophyll and being incapable of manufacturing its own food, lives off dead or living plant or animal matter. The body of a fungus consists of delicate individual threads known as hyphae, many of which form branched systems called mycelia.

LESION (lee-zhun)--A localized spot of diseased tissue. Spots, cankers, blishers, and scabs are lesions.

MYCORHIZA (My-co-ree-za)--A mutually beneficial relationship of roots with fungi. Some trees cannot grow normally without the presence of MYCORHIZAL fungi.

NEMATODE (nem-a-tode)--A roundworm having a tubular body with a mouth and well-developed alimentary canal.

PARASITE--An organism that obtains its nutrients wholly or in part from another living organism.

PESTICIDE--An agent that destroys pests, such as a fungicide, insecticide, or nematocide.

PHYSIOLOGIC RACE--A subdivision of species of fungus based on its ability to infect a selected variety of its host plant.

RESTING SPORE--A spore, often thick-walled, that can remain alive in a dormant condition for some length of time, later germinating and, in pathogenic fungi, initiating infection.

SAPROPHYTE (sap-roe-fight)--An organism that feeds on dead organic matter. Adjective: saprophytic.

SCLEROTIUM (sklee-roe-she-um)--A hard, compact, rounded mass of fungus filaments (hyphae) which usually serves as a resting body to carry the fungus through unfavorable weather. Some fungi can survive for many years in soil, plant refuse, or seed by menas of sclerotia. They vary in size from those that are microscopic to some that are several inches in diameter.

SPORE--The one- to many-celled reproductive unit of a fungus. Spores correspond in function to the seed of plants. Some spores are very light in weight and can be readily blown about by wind; others are moved about by water, man, animals, insects, and machinery. When conditions are favorable, any viable spore is capable of germinating and producing a new fungus body.

SPORULATION--The process of producing spores.

VECTOR--An agent that transmits disease.

VIRUS (vye-rus)--An infectious agent too small to be seen with a compound microscope.

QUESTION AND ANSWER SESSION ON TURFGRASS DISEASE AND INSECT OCCURRENCE

QUESTION:

What type of spraying do you think is getting the best results--fine spray or drench type?

ANSWER: (Dr. Gould)

Somewhere in between is getting the best. I don't think a fine spray is necessary at all. Actually, in our experimental work we went to only a 40-pound pressure. The important thing always is to have good coverage.

QUESTION:

How long after application of fungicides should we wait before applying water such as though irrigation.

ANSWER: (Dr. Gould)

I have no evidence to back it up, but I feel sure that the job is done within 30 minutes after application. It's a case of kill right away or it's not going to work.

One point that I would like to make very clear here and that's what Dr. Telford has brought out previously in that the mercuries are very dangerous to handle because they will be absorbed through the skin. If you have certain men who are more susceptible to burning from the mercuries, than get someone who does not react so in applying them. Applicators should always use gloves for protection in applying mercury fungicides.

Conference Attendance 1962

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