

PROCEEDINGS
of
1957 TURF CONFERENCE

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PROCEEDINGS OF THE 1957

MIDWEST REGIONAL TURFGRASS CONFERENCE

The need for technical information for turfgrass management constantly increases. We are pleased to present herein 34 articles presented by speakers especially for these Proceedings.

A copy of these Proceedings were mailed to:

1. The 511 attending the 1957 Midwest Regional Turf Conference.
2. The Superintendents of Member Organizations in the Midwest Regional Turf Foundation not attending the Conference.
3. List of those in educational activities.

Additional copies are available at \$ 1.00 each from:

W. H. Daniel, Executive-Secretary
Midwest Regional Turf Foundation
Department of Agronomy, Purdue University
Lafayette, Indiana

Attendance divided by interest as
judged by Registration card

Golf Courses	287
Turf Materials and Supplies	79
Sod & Landscape Service	43
Parks (most have golf courses)	24
Industrial Grounds	18
School Grounds	11
Cemeteries	9
Non-profit and Universities	<u>42</u>
Total	511

Distribution by states

Indiana	128
Illinois	181
Ohio	93
Michigan	33
Wisconsin	19
Kentucky	13
Missouri	15
Outside Midwest	<u>31</u>
Total	511

Attendance by area represented by
the 13 Golf Course Supts. Ass'n.

Midwest	132
Indiana	73
Northern Ohio	37
Cincinnati	28
Michigan	25
Miami Valley	20
Mississippi Valley	17
Wisconsin	19
Michiana	21
Kentuckiana	17
Central Illinois	47
Central Ohio	6
Western Michigan	8
Outside Midwest	30
Purdue	<u>31</u>
Total	511

TABLE OF CONTENTS

	<u>Page</u>
President's Report.....	Ward Cornwell 1
Training for Tomorrow.....	H. B. Musser 1
Soil is Basic.....	J. R. Watson 3
Ten Years of Nitrogen Studies.....	H. B. Musser 6
Nutrition is Basic.....	S. A. Barber 8
Nutrition is Basic.....	H. B. Musser 9
Adequate Nutrition.....	C. G. Wilson 11
Potash Important for Golf Greens.....	Werner L. Nelson 13
Water is Basic.....	Dan Wiersma 15
Water is Basic.....	C. G. Wilson 17
Soil Modification - Practices with Putting Green Soils	
	M. H. Ferguson 19
Serving our Customers.....	R. C. Meier 23
Technology in Sales.....	Jess Taggart 25
Some Geology of our Midwest.....	W. N. Melhorn 28
What is your Program?.....	Leo J. Feser 30
Military Turf Uses.....	Burton F. Kiltz 33
Producing Sod.....	W. H. C. Ruthven 35
Problems in Growing Sod.....	H. B. Musser 36
Seeding Principles.....	H. B. Musser 39
Fast Turf Establishment - Through the Use of Mulch and Hydraulic Seeding.....	Charles O. Finn 41
Insect Control in Turf.....	Donald L. Schuder 44
Chemicals for Crabgrass Control.....	John E. Gallagher 48
Maintaining Aprons, Observations.....	C. G. Wilson 52
Maintaining Aprons Around Greens.....	O. W. Young 54
The Public and Their Golf Courses.....	John Vaughn 55
League Golf and My Course.....	Harold W. Glissman 56
Turf Organizations and their Programs.....	W. H. Daniel 60
Seed Field Problems.....	Arden Jacklin 62
Improved Seed for You.....	Arden Jacklin 68
Disease Control for Lawns and Fine Turf.....	M. C. Shurtleff 70
Bluegrass Rust Studies.....	Michael P. Britton 78
Nitrogen Fertility Research.....	Norman Goetze 79
Soil Test Summaries Show Turf Needs.....	W. H. Daniel 82
Factors in Selecting Grasses.....	Fred V. Grau 85

PRESIDENT'S REPORT 1957 ANNUAL MEETING

Ward Cornwell, Supt., Detroit Golf Club, Detroit, Michigan

I am happy at this time to make a progress report for 1956 at which time we arrived at an all time high of 285 membership. Our 1956 Turf Conference reached an all time high in attendance with some 485. This increase, which we have enjoyed every year, has come about without any high pressure sales campaign on our part. The steady growth has been the results of the fine work that has been done by Purdue University and its fine staff under the direction of Dr. William Daniel. I believe at the present time he has 13 men working, or receiving support in turf. This alone will account for the steady growth of this great Foundation.

During the past year for the first time a Foundation scholarship was awarded to Tom Hodges, a Turf Management major from Bedford, Indiana.

If I may, I would like to look into the past for a moment. I started coming to Purdue in 1942 and since then have missed only one meeting, making this my 15th Turf Conference at this fine University. I had the pleasure of sitting in on the forming stages of this Turf Foundation when 15 - 20 men was considered a good sized group. So, naturally I am very proud and happy to see what we have all seen in the last two years.

I cannot go on farther without thanking those who helped form and develop the Midwest Foundation. Those on Purdue Campus include: Dr. Clevitt, Dr. Scarseth, Dr. Mott, Dr. Daniel and his co-workers. I have served on the Board of Directors for the last 5 years, with this last year as your President. I have enjoyed every one of these years. Now that I am about to become an EX-President, I am sure that I will enjoy that too. I will always have a warm spot in my heart for the Midwest Turf Foundation of Purdue University, and will always stand ready to help out in any way that I can. Best of success for the future, and good evening friends.

TRAINING FOR TOMORROW

Prof. H. B. Musser, Penn. State University
(Presented before Golf Course Supts. Section of M.R.T.C.)

The future outlook for anyone trained in Turfgrass Management is brighter today than at any time in the history of this specialized field. Because of the extremely short supply of trained personnel, the number of good job opportunities is far in excess of those qualified to fill them. I do not believe it is going too far to say that it offers by far the best opportunities of any branch of Agriculture.

It is not hard to find the reasons for this. Increased leisure time has created a demand for more sports and recreational areas. The tremendous increase in house building and movement of industry to suburban areas has developed a consciousness of and desire for good turf. Rapid highway expansion has created a need for thousands of acres of protective cover along roadsides. Cemeteries, schools, public housing, public and private institutions, air-

fields and even motels have become turf-conscious and are adding to the snow-balling demand for a high quality product.

Industry, always eager to find new markets for its products, has been quick to recognize the potentialities in this field. Fertilizer companies, manufacturers of chemical herbicides, insecticides and fungicides, seed producers and dealers, manufacturers of equipment, to say nothing of the distributors of all these things, are bidding for the services of the men whose training qualifies them to advise and direct industrial development to take advantage of this tremendous potential market.

And they are not only bidding against each other. They must compete with golf courses, that need competent superintendents; with commercial nurseries that require trained men for production of sod and planting stock; with parks, cemeteries, municipalities and institutions who require grounds supervisors; with contractors for turf projects who must have trained agronomic supervision of their operations; and with highway departments where turf management training is especially important because of the difficulties of cover establishment on so many areas.

The situation is just as serious in the educational field. Pressure is mounting in the Colleges and Universities serving Agriculture to provide answers to the many problems of turf production that still are plaguing the industry, and to supply better service in getting the answers into the hands of those who need them.

Granted that a case has been made for the need for trained men and that the opportunities exist for using them, what, then, constitutes adequate training to take advantage of these opportunities?

Anyone who has attended this conference and listened to the discussion must have been impressed with the technological developments in this field. The production and utilization of better grasses; basic principles of plant nutrition as they affect practical fertilizer programs; the use of chemicals in the control of weeds, insects and diseases; principles of soil physics as applied to soil modification and turfgrass maintenance; these, and many more, point up the necessity for at least a working knowledge of the science that is the basis of the art of turfgrass management. This, then, must be an important part of the training in this field. However, it is by no means the entire picture. Industry will demand training in salesmanship, in the art of meeting people, and in the fundamentals of business methods. Many jobs, such as those of Golf Course Superintendents, Park Supervisors, and Nursery Managers will require training in handling and directing labor and in accounting methods. Research and teaching demands very specialized training in the entire field of science and practice as it applies to turfgrasses.

This is the challenge. It can be met by anyone who has the desire and fortitude to tackle it. Facilities are available to provide it. They cover 4-year courses at Colleges and Universities to take care of those jobs where detailed and extensive study is needed; 2-year courses designed to serve the practical training requirements of direct supervision of turfgrass production and management; training by on-the-job experience supplemented with knowledge gained at short courses and conferences such as this. These facilities can accommodate much larger numbers than are presently taking advantage of them.

The general shortage in trained manpower is, of course, partially responsible for this situation. But it does not entirely explain the excessive shortages based on demand and opportunities. The fact is that the turfgrass field is not getting even its fair share of the limited supply. Experience indicates that this may be due in large part to a lack of understanding of the possibilities in this field and an even greater lack of knowledge as to the training facilities available. It seems obvious that, until more serious efforts are made to publicize and disseminate this information, the shortages will continue and may become even more serious.

SOIL IS BASIC

J. R. Watson, Jr., Chief Agronomist,
Toro Manufacturing Corporation, Minneapolis 6, Minnesota
(In cooperation with A. R. Bertrand, Dept. of Agronomy, Purdue University)
(Presented before Basic Section of M.R.T.C.)

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

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

Chemical Properties of Soil. The chemical properties of soils include the reaction (pH) and the fertility relationships. The pH of a soil refers to the degree of acidity or alkalinity; a pH of 7 is neutral, above 7 alkaline, below 7 acid. Although a pH range of from 6.5 to 7 or 7.2 is generally considered optimum for turfgrass growth, a somewhat higher level (pH 7.8 to 8.0) is, in general, not sufficient cause for alarm. Grasses growing under such conditions may exhibit "iron chlorosis," but this is easily corrected by the application of iron sulfate or the newer chelated compounds. When the pH is below 6.0 the addition of lime is recommended.

Turfgrasses need liberal feeding throughout the growing season; consequently, fertilization which supplements the natural plant food supplies of the soil is one of the most important factors in the care and maintenance of turfgrass. Turfgrass will become thin, unthrifty and invaded with weeds unless an adequate level of fertility is maintained.

Biological Properties of Soil. Biological soil properties include the micro and macro plant and animal populations of the soil. For the most part, soil organisms are beneficial, although certain disease organisms, weeds and insects are harmful and must be checked by the application of the appropriate fungicide, herbicide or insecticide.

Organic matter comprises only a small percentage of the total volume of most natural soils, but it plays a vital and significant role in all physical, chemical and biological soil properties and functions. The original source of organic matter is plant and animal tissue, the latter contribution being far less than the former. The amount of organic matter in a natural soil is controlled by the prevailing temperature and moisture relationships. These factors, along with nutrient supply, control biological activity; hence, the amount of organic matter. Organic matter in soil serves as a constant source of plant food, especially nitrogen and sulphur; it serves as food (energy) for micro-organisms; it improves the structural relationships, thereby promoting desirable water holding capacity and aeration.

Excessive amounts of organic matter may create rather serious problems, especially on intensively managed areas such as golf greens. Most recommendations today call for only 7 to 10 percent by volume of peat when soil is being modified for construction.

Physical Properties of Soils. The physical properties of the soil (texture, structure, porosity, etc.) govern the infiltration, retention and movement of moisture in the soil medium, controls the air-water relationships, and, along with the chemical and physical properties, determines the type of turfgrass that grows best under a given set of climatic conditions. Each of the physical soil properties exert a direct effect on plant growth and each is dependent, one on the other, for the ultimate effects they produce on other soil properties and on turfgrass growth.

Texture is a soil term which refers to the size of the individual soil particles. Sand, silt and clay are the basic textural terms. "Soil class" (terms like sand, clay, clay loam, sandy loam, etc.) indicates the predominant soil separates. Texture is a most important characteristic of soils because it describes, in part, the physical qualities of soils with respect to porosity, coarseness or fineness of the soil, soil aeration, speed of water movement in the soil, moisture storage capacity and, in a general way, the inherent fertility of the soil. Sandy soils are often loose, porous, droughty and low in fertility, whereas clay soils may be hard when dry, or plastic when wet, poorly aerated, but possibly high in fertility. Between these two extremes we find the loams and sandy loams which, in general, are more desirable for plant growth.

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

The structural aggregation of soil is greatly influenced by the amount of colloidal organic matter present. The end product of decay of organic matter -- humus -- is an integral part of soil aggregates and is sometimes referred to as the cementing or binding agent in aggregates. Stability of aggregates is directly dependent upon the amount of organic matter and the degree of biological activity obtaining. Synthetic soil conditioners, properly applied, will stabilize existing aggregates against water action, but not against player and equipment traffic. In this respect, aggregates so treated are no different than naturally occurring water stable aggregates. The structural aggregation of soil determines, to a large extent, the porosity, permeability and water holding capacity of soils.

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

Two types of porosity are recognized -- textural and structural. Textural porosity is that associated with individual particles of sand and silt. Structural porosity is the porosity associated with the clay fraction of the soil. It is the porosity found within the aggregate.

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

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

TEN YEARS OF NITROGEN STUDIES

Prof. H. B. Musser, Penn. State University

The studies of rates of nitrogen utilization by cool season turfgrasses, which are the basis of this discussion, were begun at Penn State in 1947. Critical data from field, laboratory, and greenhouse trials actually covers a 10 year period.

The principal objectives of the experimental program are to determine:

1. How grass responds to the various forms of nitrogen present in different nitrogenous fertilizing materials, and
2. The best methods of using these materials in a turfgrass fertilization program.

In discussing these objectives, typical results obtained in various years are used to illustrate what we believe may be expected from the materials studied.

The first task was to determine how each material performs from the standpoint of rate of nitrogen release as measured by their effect on growth rate of the grass throughout the entire growing season. In attempting to answer this question, single applications of each product were made at rates to supply from 2 to 8 pounds of nitrogen per 1,000 sq.ft. Treatments of this type have been made each year during the 10 year period. We have studied their effects on Kentucky bluegrass, red fescue, and bentgrass in both greenhouse and field trials.

The data obtained indicates clearly that nitrogenous fertilizers may be divided into three classes on the basis of the rate at which the nitrogen they carry becomes available. The graphs in Slides (1, 2 and 3) are typical of results obtained throughout the entire 10 year period of testing. They show the relative responses of Kentucky bluegrass, Red Fescue and Bentgrass to applications of 6 pounds of nitrogen per 1,000 sq.ft. made in early spring. Columns represent the increase in clipping weight at each clipping period for the treated over the untreated plots. The graphs compare the grass response for the first 6 clippings following fertilizer applications in the spring, and the last 4 clippings in September. A much greater proportion of the nitrogen from Ammonium sulfate was exhausted early. They also show the intermediate character of the response from Milorganite and the slow rate of nitrogen release from urea-form.

While the relative response of all grasses was the same, there was a very marked difference in the degree of response of each, particularly during the spring growing season. This is shown in Slides 4, 5 and 6. Fescue is essentially a cool season grass and responds strongly to high levels of nitrogen in the spring. Kentucky bluegrass (Merion mix.) is intermediate and bentgrass much slower. These results throw some light on the basic differences between the materials and also on how they can be used most efficiently on the various grasses.

Since it is quite obvious that the rate of nitrogen release is materially different as between the various classes of nitrogenous fertilizers, it is

evident that they must be handled differently. Results of field trials on putting green turf conducted during the season of 1956 illustrate this. Slide 7 shows the growth rate picture throughout the season obtained from a total of 8 pounds of nitrogen per 1,000 sq.ft. applied using the following materials and split rates:

	<u>Total</u>	<u>Rate</u>
Urea-Form	8 pounds	Single application (Fall)
Urea-Form	8 pounds	3 pounds (Fall), 5 pounds (Spring)
Milorganite	8 pounds	1.6# per month
Amm. Sulfate	8 pounds	0.8# at two week intervals

Results show that, except for some difference in the total clipping weights obtained, the growth curves for all of the materials were very similar. Turf quality also was closely comparable. The practical value of these results is that they give us a better working knowledge of how to handle these various nitrogenous materials. It should be emphasized, however, that the important consideration is the necessity for good nitrogen distribution and not the actual quantity used.

These results have been confirmed by experimental work at other institutions, notably Rhode Island and here at Purdue University. They bring a relatively new material, urea-formaldehyde, into the turfgrass fertilizer picture. This is a complex chemical compound. Its value as a source of nitrogen for turfgrass depends upon how it is produced. A working knowledge of the standards of quality under which it is sold is necessary in order to buy and use it intelligently.

The following diagram may be of assistance in understanding its general character from the standpoint of the availability of the nitrogen which it contains. (Slide B.)

The separation of the nitrogen into different availability classes is based on arbitrary laboratory tests of solubility in cold and hot water. These are the tests adopted by the Association of Official Agricultural Chemists and are accepted as the indications of the fertilizer value of the material. It will be noted that the portion of the total nitrogen that is not soluble in cold water is designated as Insoluble Nitrogen. In satisfactory material this constitutes about 75% of the total nitrogen. This portion is further divided into Hot Water Soluble and Hot Water Insoluble fractions. The Hot Water Soluble must be a minimum of 40% of the total Insoluble. The better materials will contain from 55 to 65% of the Hot Water Soluble nitrogen. This Hot Water Soluble percentage is called the Availability Index of a U-F material. The total Cold Water Soluble plus the Hot Water Soluble is the quantity of nitrogen which it is assumed will be available for use by the grass during a single growing season.

The best measure of value of U-F compounds that is available to the purchaser at the present time is the Total Insoluble Nitrogen and the Availability Index. He should insist on having both figures.

NUTRITION IS BASIC

S. A. Barber, Dept. of Agronomy, Purdue University
(Presented before Basic Information Section of M.R.T.F.)

There are at least 14 nutrients that are required by the plant for growth. I only intend to discuss a few of these; the ones which we are more likely to come in contact with.

First, let's consider the nutrients calcium, magnesium and potassium. I have grouped these together because they have a lot of similarities.

1. They are all cations
2. They are needed in relatively large quantities
3. They are held on the soil clay and organic matter as exchangeable ions.
4. Except for sandy soils, they do not leach readily

These ions are held by the clay and organic matter which is a large particle with many negative charges on its surface which balance these cations.

Another cation, hydrogen, usually is associated with these three. In fact, the plant root swaps hydrogen for calcium, magnesium and potassium in order to take them into the plant root.

There are two things we know for sure about the uptake of a plant nutrient. One is that it is an exchange of hydrogen for a cation, or the bicarbonate or hydroxyl anions for an anion, and the second is that the plant has to use energy by burning sugars to provide the energy for the work involved.

We need nutrient balance. Calcium, magnesium, potassium and hydrogen must be in balance for good plant growth. Fortunately the range of tolerance is wide so that it is fairly easy to keep things in balance. Calcium is low and hydrogen is excess, so out of balance, in an acid or sour soil. There is so much hydrogen present, the plant has difficulty getting enough calcium.

When we apply limestone we reduce the amount of hydrogen present and increase the amount of calcium and magnesium so that the balance is brought to a desirable status. In a soil that has free calcium carbonate, which may happen in a soil watered with water high in calcium salts, we may get high calcium and lowered potassium, so out of balance. The balance we need is also affected by the plant. Grasses can get enough potassium with a much wider Ca-K ratio than can clovers, or corn, or soybeans.

The two other nutrients we use in large amounts are nitrogen and phosphorus. Nitrogen comes in three forms; ammonia, nitrate and in organic combinations. Ammonia is also a cation; it is held by the soil and is not lost by leaching except in sandy soils. However, nitrogen as ammonia quickly changes to nitrate once it is in the soil. This process is faster at warm temperatures than in cool temperatures. It is also faster in soils with a high pH (pH. is an intensity measurement of the hydrogen ion activity). Nitrate nitrogen moves with the water in the soil. It is an anion and moves freely. It is not held by the soil. Other anions of less significance nutritionally, but which also move about freely, are sulfates and chlorides.

Because ammonia changes to nitrate and nitrate can be leached out, then nitrogen needs to be applied closer to the time the plant needs it so that it will still be present. Organic forms of nitrogen placed in the soil will break down to ammonia and then be changed to nitrate by soil micro-organisms. Since this is a longer process, the rate of release is usually slower. The plant can use either the ammonia or the nitrate form of nitrogen.

Phosphate does not move in the soil because it is tied up with iron, aluminum and calcium. However, it still can be obtained by the plant because it goes into the soil solution rapidly enough to replace what the plant uses. Phosphorus is not lost by leaching. A balance also must be obtained between nitrogen, phosphate and potassium.

The increase in growth of a crop as you increase the amount of a nutrient, follows the curve of diminishing returns and you eventually reach a point where there is very little increase in yield as you increase the amount of the nutrient added. This is when all other growth factors are held constant at optimum levels. Then, as we increase beyond this point, we may decrease the amount of growth. This is because we are getting out of balance. The excess of the nutrient added starts to affect the ability of the plant to forage for the other nutrients.

The optimum situation is that one where each nutrient is increased to the point where we are closely approaching maximum production. The other nutrients, mostly minor elements, follow these same relationships to a lesser degree. They are only needed in small amounts so that on the majority of soils there is enough present. However, on some soils we can create deficiencies of these when some of our major nutrients get out of balance. For example, excess calcium may create a manganese deficiency, and excess phosphorus favors iron deficiency in turf.

NUTRITION IS BASIC

H. B. Musser, Penn. State University, University Park, Pennsylvania
(Presented before Basic Information Section of M.R.T.C.)

The dictionary defines nutrition as "the sum of the processes by which an animal or plant absorbs, or takes in, and utilizes food substances." Successful turfgrass management requires a working knowledge of the basic principles back of the actual processes of absorption and utilization of plant food materials. The good golf course superintendent, or grounds maintenance supervisor, does not apply 10 pounds, or 20 pounds, or 50 pounds of fertilizer per 1,000 sq.ft. to his turf area because he heard Joe Doaks, his neighbor, say "that's what he does." Nor should he do it simply because he has read it in the usual type of "do or don't" lawn circular, or article in some garden magazine. Sooner or later that way is sure to end in disaster. And disaster we cannot explain or correct because we do not have the basic facts back of what caused it.

What was the basic facts on which a turfgrass fertilizer program should be founded?

1. There are certain essential nutrient materials that plants use for their vital processes of growth and development. There is a rather long list of these and perhaps for this particular discussion we should confine ourselves to only those that usually are the most important. These are nitrogen, phosphorus and potassium. They are of major importance because either they are used in relatively large quantities, or are so deficient in soils that they are limiting factors in plant growth. The first thing we must know about them is what materials we must use to supply them. We cannot get them in pure form, but must take them as chemical compounds with other things. Thus, we use ammonium sulfate for the nitrogen which it contains, but before we can handle it intelligently we must know that for every 100 pounds of sulfate of ammonia we apply, we get only 20 pounds of nitrogen. Similarly, when we apply 100 pounds of an organic material, such as Milorganite, we are actually getting 6 pounds of nitrogen and about 4 pounds of phosphate. Fertilizer companies mix many different materials which carry varying quantities of nutrients and sell them as commercial fertilizers. The value of any of these is determined by the amount of plant nutrients it contains. Thus, 100 pounds of a 5-10-5 fertilizer contains 5% or 5 pounds of nitrogen, 10 pounds of phosphate, and 5 pounds of potash.

2. The second basic fact that must be understood about plant nutrition is how plants get these nutrient materials. This can get quite complicated because absorption of food materials is influenced by so many things. The basic thing to remember, however, is that plants do not have mouths. Food materials must be absorbed through the walls of their tissues. So water becomes an important factor in plant nutrition. The food materials must be dissolved in water before they can be absorbed. Since many of the materials used as sources of plant nutrients are not directly soluble in water, we run headlong into the necessity of knowing what materials must be changed into forms that can be absorbed, how long it takes to accomplish this, and how it is done.

3. This is the third set of basic facts necessary to the intelligent use of fertilizers. The important relationship here is the tremendous part the soil plays in plant nutrition. Its physical and chemical character not only largely controls the total quantity of nutrients that can be held and will become available to plants over a given period of time, but also materially affects the rate at which this takes place. Since this is both a chemical and biological process, it is essential that we have a working knowledge of the soil conditions best suited to provide optimum conditions for chemical processes and for the soil microbes to do a good job. Perhaps one illustration will serve to clarify this. Plant roots cannot function properly in the absorption of nutrients unless liberal supplies of oxygen are present in the soil air surrounding them. Where soils are heavy and compact, the openings between individual soil particles are restricted. Air moves slowly through them and the oxygen which it contains is rapidly exhausted. This slows down the up-take of nutrients with prompt effects on the growth and health of the grass. It also affects the development and activity of the soil microbes that are necessary for converting nutrients into soluble form.

4. An understanding of soil reaction (acidity) also is necessary in setting up a sound fertilizer program. The basic facts here include such things as the reduced availability of phosphorus under acid conditions, the injurious effects of acidity on root formation and functioning, and the suppression of activity of desirable soil organisms.

There has been no attempt in the above brief outline to do more than use some of the basic facts of plant nutrition to illustrate its importance. These principles, along with others, are the basis for every sound fertilizer recommendation that ever has been made, and of every successful turf feeding program ever practiced. An understanding of them and their application marks the difference between the satisfaction that comes in knowing that what you are doing is right and the persistent question of whether what someone else told you might be wrong.

ADEQUATE NUTRITION

C. G. Wilson, Agronomist
Milwaukee Sewerage Commission, Milwaukee, Wisconsin
(Presented before General Turf Section, M.R.T.E.)

Fertilizer practices are first to be suspected by some when troubles occur. The inexperienced clamors for soil tests or changes in his fertilizing program without careful thought. One should always remember that other management factors must be right for fertilizer to perform correctly.

The weather, the soil, the wrong grass, chemical or mechanical damage, insects, disease and misuse of water also take their toll of good turf. Changing fertilizer practices may no more be the answer for these than expecting new spark plugs to run a car with an empty gas tank. Adequate nutrition is a relatively simple matter when the other basic factors are not limiting growth.

We consider soil tests important. Their value is directly related to the way one takes the soil sample, the laboratory extraction methods used, and the person who interprets the results. Samples of the same diameter must be taken at exactly the same depth to be meaningful because turf is an undisturbed crop. Dr. Daniel mentioned a few years ago that, "unlike the farmer we can't plow up our mistakes each year."

Plant food elements vary greatly with depths on soils under turf. Available phosphorus can be 75 pounds per acre at the 2 inch depth, and only 25 pounds at the 4 inch depth. Seventy-five pounds by the Truog method is ample where clippings remain. The 4 inch sample would be considered low. Most of the phosphorus applied is fixed by the soil in the top 2 inches. Thus, an error in sampling would result in a recommendation to apply phosphorus where none is needed. It is for this reason that we insist all samples be taken at an exact depth of 2 inches.

Each sample must be a composite of 8 to 10 - one-half inch diameter plugs truly representative of the soil type of which the turf is growing. Sands leach more rapidly than clays, and are more likely to show plant food deficiencies. The nutrient requirements on areas where clippings are removed differ from those where clippings decay in place to return plant food to the soil. Inexpensive soil sampling probes are available through many golf and lawn supply dealers, and soil testing services.

The commonly used laboratory tests such as Purdue, Truog, Morgan, Spurway, Edwards, etc., differ essentially in the strength of the solvent used to extract soil nutrients. A small amount of soil is extracted with a relatively large volume of solution for a definite period of time. The solution dissolves all the water-soluble nutrients, and the easily soluble ones which are readily available to plants. Some of the solvents are too weak for turf areas. Then the tests may not show any difference and fail to distinguish between soils with a high and low level of phosphorus and potash. The tests may show an acute need which is not borne out in the field.

Correct interpretation of the laboratory analysis can only be made by someone with a knowledge of turf. A classical experiment tried by an eastern university some years ago will illustrate this point. Copies of the same laboratory report were sent to different scientists whose training qualified them to answer questions on vegetables, fruits, wheat and pasture, respectively. Each man was a recognized authority in his field. Each one made different fertilizer recommendations because each crop required different treatment for best results.

As Dr. Daniel pointed out, soil tests are designed to determine possible need for lime, and to estimate the amount of water soluble and immediately available nutrient elements in the soil. Phosphorus, potassium, calcium and magnesium are customarily determined. Tests for nitrogen are not reliable on turf areas. Need for this element can be judged by behavior of the grass. Poor color, thin turf, slow rate of growth and presence of weeds and clover are the customary signs of nitrogen need.

Soil test results serve as an inventory of soil fertility levels. When used that way, they are a useful guide in devising an effective fertilizer program.

Plant food needs are also affected by the length of the growing season, the weather, and the type of grass. Eight pounds of nitrogen per 1,000 sq. ft. is considered adequate at State College, Pennsylvania. Sixteen to eighteen pounds is required in southern California to produce similar results. The difference is the length of the growing season.

The weather has a pronounced effect on nutrient levels. The cool, wet 1956 season was entirely different from hot and humid 1955. Cool weather and adequate moisture induce rapid growth. This is made at the expense of the soil unless provisions are made to add more fertilizer. Those who thought nitrogen was overdone in 1955, and lessened fertilizer applications as a result, ended up with dollarspot in 1956.

Kentucky bluegrass needs more available phosphorus in the soil than bent grasses or red fescues. Deeply rooted grass utilizes plant food that is lost to shallow rooted turf. When any grass is shallow rooted from adversity, light and frequent feeding is essential.

In conclusion, it should be said that a healthy plant is a growing plant. It is wise to avoid both over succulence and starvation. Adequate nutrition means steady, even growth throughout the season if other basic factors are right. Too much fertilizer may be applied in any single application. The common error is to expect a little fertilizer to do too much.

POTASH IMPORTANT FOR GOLF GREENS

Werner L. Nelson, American Potash Institute, Lafayette, Indiana
(Presented before Golf Course Section of M.R.T.C.)

Fertilization of golf greens requires much more care than fertilizing fairways or lawns. The grass on the greens is trimmed short and frequently. This keeps the root systems rather weak and limited because the manufacturing system, the leaves, has limited opportunity to make carbohydrates to transfer to the roots. Also, the clippings are removed from the greens, which results in a constant loss of fertility. In view of this it is important that these grasses be fertilized and handled properly.

We all recognize that maintaining an adequate supply of potassium is only one of the many practices important in maintaining a good turf. However, this discussion will be limited to potassium and some of the more important aspects will be considered.

Golf Green Soils Low in Potassium

At the 1957 Midwest Turf Conference, W. H. Daniel reported that of 369 soil samples from putting greens only 1% were medium or less in P, and 92% contained excess P. On the other hand, 70% were medium or less in K. This would indicate that potassium deficiency is probably preventing top green performance in many instances.

Why are Golf Green Soils Low in Potassium?

High removal of potassium. The frequent clipping and removal of these clippings causes a steady drain on nutrient supplies. Some information is available as to the total pounds of dry matter, N, P_2O_5 and K_2O removed per 1,000 sq.ft. (Table 1). In all instances the removal of N was the greatest, with K_2O being next, and P_2O_5 the least.

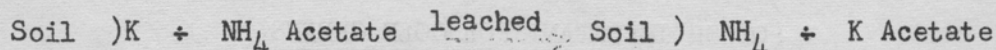
Table 1. Annual removal of dry matter, N, P_2O_5 and K_2O from golf greens*
Pounds removed per 1,000 sq.ft.

	Bermuda Grass Univ. of Natal	Bent Grass Milwaukee	Bermuda Grass Memphis
N	3.36	4.67	5.62
P_2O_5	0.10	1.74	1.48
K_2O	2.17	3.13	3.36
Dry Matter	109.2	96.7	120.2

*Reported by O. J. Noer and J.E.Hammer, "The Yield and Chemical Composition of Clippings from a Bermuda Grass Green". Presented in Turf Grass Section at American Society of Agronomy Meeting - November 14, 1956.

Considerable leaching of potassium. In 1940 Scarseth emphasized the loss of potassium from golf greens by leaching*. The greens then suffer from a lack of potash in late summer and early fall. Frequent use of ammonium sulfate or urea replaces the potassium from the soil colloids. Watering then leaches the potassium out of the root zone.

In the quantitative determination of exchangeable potassium in soils, this same principle is used. The soil is placed in a funnel and leached with ammonium acetate. The ammoniacal ion replaces the potassium from the exchange complex as follows:



The potassium in solution in the beaker is then measured.

The frequent use of nitrogen and water on golf greens is, of course, essential. It does emphasize, however, that conditions are set up for considerable leaching of potassium and that careful attention must be given to maintenance of potassium supply. In contrast, phosphorus does not leach out because it is fixed in the soil.

Functions of Potassium

Potassium has many functions, but only a few will be mentioned.

Movement of plant foods from tops to roots. Potassium is important in helping the carbohydrates manufactured in the leaves to move to the roots. The leaves and roots are connected by vascular bundles - the so-called "pipelines". In plants starved for potassium these pipelines become badly damaged and the roots are starved for foods. Too, the leaves may be filled with food which cannot be translocated to other parts of the plant. Controlled studies show that low potassium reduces root development.

Disease resistance. There is considerable indirect evidence and some direct evidence that potassium deficient plants are more subject to disease. Lawton of Michigan State has demonstrated that leaves from certain potassium-deficient plants have a rather high accumulation of sugars. This, along with accumulation of other compounds including nitrates, may make conditions more favorable for development of fungous diseases once the plant is infected. Burton of Georgia has shown the greater prevalence of a leaf spot disease, Helminthosporium, on low potash plots of Coastal Bermuda.

This does not mean that fertilizing with potash will eliminate the necessity for controlling diseases, but such outbreaks will be less disastrous and more easily controlled when the supply of potassium is adequate. The grass should be tougher in the important July and August period, and soft, lush growth with nitrogen alone avoided.

Drouth Resistance. Plants well supplied with potassium have a lower rate of transpiration than soft lush plants low in potassium. Hence they are more drouth resistant. Work in Rhode Island shows that these harder plants were also better able to resist keen frosts.

* Indiana Agr. Exp. Sta. 52nd. Ann. Rept. p. 48, 1939.

Density of Turf. Experiments at New Jersey have shown that on soils low in phosphorus and potassium, additions of these elements induce branching and increase density. The amount of growth below the point where grasses are customarily mowed was increased 50 to 100%.

Determination of Potassium Needs

Soil Tests. Periodic soil tests are essential in determining the potassium level in the soil. Samples of each green are simple to take and all states have official soil testing laboratories to test the soil and make recommendations.

Tissue tests. Tissue tests are a convenient means of keeping a running check on the potassium status. There are a number of methods, but the filter paper technique is gaining in popularity because of its simplicity and rapidity.* The leaf juice is squeezed on a suitably prepared paper and after washing with an acidic solution the test is read. A number of these kits are available.**

Addition of Potassium

Additions should be governed by soil and/or tissue tests. There, of course, are a number of ways of supplying the plant nutrients needed. On soils high in phosphorus and low in potassium, a fertilizer with a higher amount of K_2O than P_2O_5 , such as one with N- P_2O_5 - K_2O ratio of 1:1:2, seems satisfactory as an initial spring application. One or two pounds of K_2O per 1,000 sq.ft. as an initial application will help to boost the potassium supply if a 1:1:1 fertilizer, such as 12-12-12 is used.

For maintenance during the season there are various possibilities. The application of K_2O mentioned above might be repeated in mid-summer. Mixtures of the nitrogen carrier and muriate of potash might be applied every month or so and watered in. The important point to remember is that on soils low in potassium the initial spring application will not meet potassium requirements throughout the season.

* G.N. Hoffer, "Fertilizing Golf Greens" Better Crops, April 1945
N.D. Morgan and G.A. Wickstrom, "Give your plants a blood test", Better Crops, May 1956.

** Urbana Laboratores, Urbana, Illinois
West Point Products Corp., West Point, Pennsylvania
Denham Laboratories, Denham Springs, Louisiana

WATER IS BASIC

Dan Wiersma, Dept. of Agronomy, Purdue University
(Presented before the Basic for Beginners Section, M.R.T.C.)

Plants and animals, no matter how simple or complex, require water for their maintenance and growth. The primary source of water for grasses is

from the soil as they absorb it through their root systems and transpire it into the atmosphere. The moisture in the soil is replenished by natural precipitation and by irrigation.

An understanding of the soil-water relationships is helpful in the growing of plants - Turf Management is no exception. Concepts and terms relating to soil moisture have been developed which tend to describe the so-called "moisture constants" which are in prevalent use today. Terms which appear in the literature and are accepted useable are defined with a brief explanation.

- (a) Infiltration rate. The maximum rate at which a soil, in a given condition at a given time, can absorb water. Rates vary with texture, structure and physical condition of the soil. The rate of infiltration decreases rapidly in most soils after only a few minutes of water exposure, and then gradually becomes constant.
- (b) Saturation. A condition where all the voids between the soil particles are filled with water. Only a temporary condition - if there is free movement of water downward; however, this is not conducive to good plant growth if allowed to exist for an extended period.
- (c) Field Capacity. The moisture content after excess gravitational water has drained away and after the rate of downward movement of water has materially decreased. Most soils are at field capacity by 2 or 3 days after water has been applied.
- (d) Permanent wilting point. The moisture content at which soil cannot supply water at a sufficient rate to maintain turgor of the plant, and turgidity will not be recovered when plant is placed in a saturated atmosphere. All plants reduce the moisture content of a given soil to about the same value before wilting occurs.
- (e) Available moisture. The soil moisture content between the field capacity and the permanent wilting point. The average available moisture per foot for the three general soil types is: for sands 0.50 - 0.75 inches; loams 0.75 - 1.50 inches; clays 1.50 - 3.00 inches.

Water is held in the soil by a tensional force; therefore, energy is required for removal. The moisture tension within the available moisture range is not linear. As the moisture decreases from field capacity, only small increases in tension occur until the permanent wilting point is approached. Near the wilting point, there is an enormous increase in moisture tension with only a small decrease in moisture content. Soils of different textural and structural composition have moisture characteristic curves which differ in shape. As clay soils dry from field capacity, tension increases more rapidly per unit decrease of soil moisture than in the case of sands.

The rate water moves in the soil is closely related to the sizes of the pore spaces. Compact layers such as hard pans and clay pans can obstruct water movement to cause a saturated condition. An abrupt change in texture,

as a clay or loam overlying a sand or gravel, will also impede the downward movement of water and likewise produce saturation.

Instruments are available for measuring the amount of water present in the soil. The two main types are those using the electrical resistance principal, and those which measure the tension directly. A practical procedure is the use of a probe and noting the moisture condition of the soil. The latter method requires some experience, but is effective and fast.

WATER IS BASIC

C. G. Wilson, Agronomist, Milwaukee Sewerage Commission
(Presented before Basic Section of M.R.T.C.)

Plants use 500 to 1,000 pounds of water to produce 1 pound of dry matter. A bentgrass putting green would closely approach the top figure given. Actually, grass in a healthy stage of growth is 80% water. These facts are obvious to one who lives in desert regions. Often they are overlooked where rainfall is considered adequate.

The amount of water used is a function of weather. Temperature, humidity, sunlight intensity, and wind movement have direct bearing on water usage by plants. Any of these will vary from day to day. Poor, thin, weedy turf associated with tree shade is frequently nothing more than competition for water.

Thus, does Dr. Watson's MAN part of "management" enter the picture. Only Man can tell if the grass really needs water, and, if so, how much should be applied. The amount to apply should equal the amount removed from the soil since the previous rain or irrigation. A common error is failure to connect moisture in the soil profile capable of supporting grass roots.

To illustrate, let us suppose the grass removed all of the available soil moisture in a loam to a depth of one foot before wilting occurred. One pass is made on the area with a traveling sprinkler. It delivers 1/4 inch per hour, which wets the loam to a depth of 2 to 3 inches. This leaves 9 to 10 inches of dry soil, causing loss of deep roots because moistures were not connected. Failure to connect moistures means one is underwatering. Applying more water than the soil will hold in its effective rooting depth is wasteful and means one is overwatering. The exception to this fundamental fact will be covered later in this paper.

To water properly it is necessary to know your irrigation system. Even at the delivery rate of only 1/4 inch per hour run-off can occur before moistures are connected. Hillside slopes, compacted soil, and excessive thatch which sheds water are a few reasons. Aerifying and spiking will help water infiltration under such conditions. Use of a soil probe (12 inches, or longer) is the only sure way to know if irrigation or rainfall is adequate.

Sprinklers apply most of their water near the head. An engineered system takes care of this by overlapping the distribution pattern. It is a simple matter to check the distribution pattern of any sprinkler. Coffee cans are used as rain gauges. They are placed every two to three feet in a straight line from the sprinkler head to the outer line of coverage. The sprinkler is run for a set period of time and then the contents of each can are measured with a ruler. This gives the precipitation rate in inches.

Grasses differ in their moisture requirements. Some are more deeply rooted than others. As an example, Kentucky bluegrass is deeper rooted than bentgrass. Deep rooting makes a plant drouth tolerant. Tolerance to drouth is strictly a function of foraging capacity, or deep rooting in the soil. In this respect tolerance differs entirely from drouth resistance even though the terms are often interchanged. A drouth resistant grass does not necessarily have to be deep rooted. In fact, many resistant plants are the first to go off color when moisture becomes limiting. The advantage is an ability to stay in a dormant condition for a considerable period of time and then revive when rains come.

The practical application of the above could govern one's choice of grasses. If moisture is limiting or must be conserved, red or Chewings fescues would be better than Kentucky bluegrass, or Alta fescue. Among the warm season grasses, Zoysia is more drouth resistant than Bermuda grass, and Bermuda grass is more drouth tolerant than Zoysia. Much of the winterkill associated with U-3 Bermuda relates to water use during early spring while the grass is still dormant. This indicates that Bermuda is not especially drouth resistant. Under controlled conditions at Davis, California, Bermuda maintains color without irrigation for well over 100 days each season. It is the most drouth tolerant grass being tested. Zoysia, on the other hand, will go off color from drouth 7 or 8 weeks ahead of Bermuda grass. It stays dormant until rains come in the fall when it resumes growth. It is a drouth resistant plant.

Good fertility levels are important in either classification. Work in Missouri has shown that corn growing under adequate fertility requires about 5,000 gallons of water to produce 1 bushel. Where plant food is limited, approximately 20,000 gallons of water is needed to produce 1 bushel of corn. Corn is a grass plant.

Certainly, one should strive to get the maximum rooting potential out of any grass. The important point to remember is sudden changes in irrigation practices fail to accomplish this end. Any grass that is shallow rooted, whatever the cause, demands frequent irrigation. The summer of 1955 will be remembered by many as the year "syringing" or "showering-off" the greens came into its own. Grass roots had vanished for a number of reasons. Those who managed for the grass tops by rapidly covering a green with a fine mist spray came through the season in fine shape. Syringing was beneficial during mid-day to lower temperatures and moisture requirements. It stopped incipient wilt that occurred on water saturated as well as dry soil. Hoagland's experiments some years ago proved that tomato plants could not absorb moisture unless oxygen was present in the root zone. The 1955 season also proved that field capacity moisture and the importance of capillary attraction has been over-emphasized for periods of stress.

We will all agree that our goal should be to water as deeply and infrequently as possible. The intelligent irrigator knows the moisture-holding

capacity of his soil and the rooting potential of his grass. He also knows that it pays to look below the surface with a soil probe. Mis-use of water encourages weeds and diseases. It ups the fertilizer bill and makes soils more subject to compaction.

SOIL MODIFICATION: PRACTICES WITH PUTTING GREEN SOILS

Marvin H. Ferguson, Director
U.S.G.A. Green Section, College Station, Tex.
(Presented before Golf Course Section of M.R.T.C.)

There are many factors one must consider in the building of a putting green. Among these are location, slope, exposure, design, contour, water outlets, soil mixture, type of grass, and many others. Probably no other factor is as important in building a putting green as is the soil mixture.

The soil mixture is important to the ultimate welfare of the putting green because it must be of such a nature that it will drain quickly, that it will resist compaction, and that it will be resilient enough to hold a properly played shot and yet not so spongy that it will hold a shot played poorly. The surface of the putting green should resist deep pitting when balls are played to it. Moisture content of the soil, as well as the amount of turf present, affects the type of putting that will occur.

There are normally five functions of a soil for plants: support, nutrients, oxygen, water and a favorable temperature. All of these attributes of a soil can be altered to varying degrees by the management. The ideal soil is one which would meet all the needs of plant growth; those special requirements imposed by putting green maintenance, and which would resist the ill effects of poor management.

Putting greens are valuable enough that we can afford to build a synthetic soil, and we must come as close to the ideal as possible. We know that we must sacrifice nutrient and water supplying power of the soil in order to meet other requirements such as rapid drainage, compaction resistance and aeration.

No "Ideal" Mixture

Where do we reach the point at which the various considerations are most nearly in balance? Much research has been done on the subject and no one has yet proposed an "ideal" soil mixture for putting greens. However, we must have putting greens in the meantime. Many are rebuilt annually and each builder has to make a decision concerning the properties of his mixture.

A putting green builder must work with materials available to him within a reasonable distance. Most builders use a mixture of sand, soil and peat. If coarse, sharp sand and reed and sedge peat are used, there will be some variation in these materials. Generally speaking, however, this variation will be relatively small compared to the difference in behavior of the

mixture which may be attributed to the soil component. It is important to know the percentages of clay, silt and sand which make up a soil. It is also necessary to know something about the characteristics of the clay fraction of this soil. The clay fraction may be very small percentagewise, but it is the fraction which produces the greatest influence upon the behavior of a soil mixture.

Studies are continuing and it is likely that our ideas will change as our knowledge increases. At the present time, however, it is believed that there is sufficient information to permit a better job of building putting greens than is presently being done in many cases.

Studies at Oklahoma A. & M. College and elsewhere indicate that 20% of peat, by volume, is the maximum that ever should be used. Fifteen percent is probably better. From 5% to 8% of clay is sufficient to permit soils to be fairly effective suppliers of nutrients. When the clay content of a soil rises above 10% it tends to become plastic and the soil compacts readily. Silt and very fine sand particles are large enough that they do not form aggregates as readily as clay particles, yet they are so small that they tend to clog pore spaces and drainageways among sand particles and soil aggregates. Therefore, we should like to have as low a silt and very fine sand content as possible in soils.

Table 1

Classification of Soil Particles According to System of International Society of Soil Science, and Mechanical Analysis of Three Soils*

		Percent in some examples			
<u>Fraction</u>	<u>Diameter,</u> <u>millimeters</u>	<u>Sandy</u> <u>loam</u>	<u>Loam</u>	<u>Heavy</u> <u>clay</u>	
Coarse sand	2.0 - 0.2	67	28	1	
Fine sand	0.2 - 0.02	18	31	8	
Silt	0.02 - 0.002	6	21	22	
Clay	Below 0.002	9	20	69	

*From Lyon and Buckman, 4th ed., p. 43 (figures rounded off, editor)

Table 1 shows the percentage of the various sizes of soil particles found in three different soil types. The sandy loam soil described in this table approaches the type generally thought to be most desirable for putting greens. If, by weight, 15% of peat or other slowly decomposable organic matter were added to this sandy loam, one would have a mixture containing 57% coarse sand, 20% fine sand and silt, 8% clay and 15% organic matter.

If we look at the second soil type, a loam, we see that the clay content is considerably higher. In order that this soil should supply from 5% to 8% of clay, we would need to mix it in the proportion of approximately 15% peat, 35% soil and 50% coarse sand. Such a mixture would then show an analysis of approximately 60% coarse sand, 18% fine sand and silt, 7% clay and 15% organic matter.

If a putting green were to be built using heavy clay as the soil component, one would only be able to use about 10% of the soil, 15% peat and

75% of a coarse sand. Such a mixture would consist of 7% clay, 75% coarse sand, 3# fine sand and silt and 15% organic matter. This mixture will come very near to supplying all the needs of a putting green soil.

Table 2

Percentages of Various Components in Putting Green Soil Mixtures
Using Sand and Peat in Combination with Soil Types Shown in Table 1.

Mix- ture	Components by percent	Coarse sand (2.0-0.2 mm.)	Very fine sand & silt (0.2-.002 mm.)	Clay	O.M.
1	Sandy Loam 85) Peat 15)	56	21	8	15
2	Loam 35) Peat 15) Coarse sand 50)	60	18	7	15
3	Heavy Clay 10) Peat 15) Coarse sand 75)	75	3	7	15

Now let us look at these three mixtures together in Table 2. We find that they are similar in many respects. Perhaps the most important consideration is that the organic matter and clay contents be similar. The clay and organic matter provides great surface area to hold moisture and nutrients. A small variation in these components can produce a very great effect on the behavior of the finished mixture. These three mixtures appear to have similar qualities, even though 85% soil went into the first mixture; 35% into the second; and 10% into the third.

Studies by Kunze at Texas A. & M. have provided some information concerning the physical measurements that may be used in judging the suitability of soil mixtures. Among these are infiltration rates following compaction, and relationship between capillary and non-capillary pore space following compaction. It was indicated by these studies that erroneous conclusions are likely if one relies too heavily upon any one physical measurement.

Drainage and Aeration

We cannot be sure, however, that these soils will be equally good in a putting green. The silt and very fine sand content of soil No. 1 is 20% while that of No. 2 is 18%. Contrast these figures with soil No. 3, which has a silt and very fine sand content of 3%. Number 3 mixture will have adequate nutrient and moisture supplying power, and it will also drain promptly. Since good drainage and ample aeration go together, this is an excellent soil.

Mixtures No. 1 and No. 2 have good nutrient and water supplying ability, but their drainage and aeration characteristics probably are not so good be-

cause of the presence of relatively large amounts of very fine sand and silt. It will be necessary to reduce the peat content a great deal to insure adequate water infiltration and percolation rates. Relatively small deviations from the optimum mixture may be critical.

It is also important that a good foundation be prepared before the soil is placed on the putting green. The following steps will insure that the sub-grade and drainage will be adequate:

1. Contour the subgrade just as the finished surface will be contoured. The base will be about 14 inches below the putting surface.

2. Lay tile in a suitable pattern on the subgrade in broad shallow trenches, using the soil from these trenches to create a slope between tiles so that water will drain to them readily.

3. Place a layer of clean gravel (approximately $1\frac{1}{4}$ " aggregate) over the tile, covering it completely. This layer of gravel will average 3" in thickness, though it will be about 5" thick over the trenches in which the tile is laid.

4. Place a layer of coarse sand, approximately $1\frac{1}{2}$ " thick over the gravel. This sand will filter into the gravel to some extent, but it will provide a zone of intermediate texture which will prevent the topsoil particles from being washed down into the gravel.

5. The topsoil mixture should be mixed off the green. A layer 10" to 12" thick should be applied. After settling, the topsoil layer should be thick enough to allow a cup to be cut out without cutting into the sand layer below. It is important that the topsoil mixture be thoroughly firm before the grass is planted. One method of doing this is by tramping it under foot until the soil is firm. This method is called "footing." After tramping the entire surface of the green, it will be rather uneven and rough. It should be raked smooth and then the "footing" process should be repeated. When the soil is as firm as one is able to get it using this process, it should be watered sufficiently to settle the surface and so that one may avoid any pockets or low spots that need to be filled.

6. Only after the surface is thoroughly firm and smooth should grass be planted. Either seed or stolons may be used. The improved strains which are nearly all planted vegetatively have been shown to be much more resistant to many of the putting green troubles, such as disease and weed infestation, than are the seeded types. After one goes to all the trouble necessary to build a putting green properly, it seems worthwhile to obtain the best grass available for planting.

As our knowledge of soils increase, it is quite likely that we will find better mixtures and better building methods. At the present time, we feel that the suggestions offered herein will permit the building of much better putting greens than many of those which have been built in the past.

SERVING OUR CUSTOMERS

R. C. Meier, Jr., Turf Equipment, Inc.
7525 Kenwood Road, Cincinnati 27, Ohio

There was no one more surprised than I when asked to speak to you. Dr. Daniel and the Program Committee felt that it might be of interest to some to hear how another average turf materials dealer operates.

First, may I present a brief history of our Company. Turf Equipment, Inc., came into being on October 1, 1954. Prior to that time we functioned solely as a distributor of garden tractors. With the adoption of our present firm name, we took on several major lines of heavy duty mowing equipment, as well as the fertilizers necessary to grow grass. This gave us a legitimate excuse to sell power mowers.

Both the owner of Turf Equipment, Charles Schiear, and I, had had little experience with the fine details of growing and mowing grass as a major crop, although we were rather well versed on machinery and motors. We bought and read books, such as H. B. Musser's "Turf Management"; we had the fortunate break of being able to attend a factory sales meeting of the supplier of our golf course mowers. This was just a few weeks after we opened shop. That experience was invaluable as we were able to talk with other dealers who had been long established in this field.

Perhaps the greatest assist in our gaining knowledge of turf work was the cooperation we received from the Cincinnati golf course and cemetery superintendents when we began to call on them. That remark is not intended as subtle flattery to make a sale. Selling a two or three thousand dollar lawn mower takes more than well chosen words. Everyone has been ready and willing to listen to us, and to answer, whenever possible, our sometimes rather stupid questions.

We look upon turf materials dealers as "middlemen". Primarily we serve as liaison men between the manufacturer of a product, such as lawn mowers, and the user. It is our business to see that insofar as is possible the user buys the right equipment for his particular job.

Too often the price of the equipment is the immediate major concern of the prospective buyer. The result of a cheap price tag purchase is like buying a pickup truck to do the work of a two-ton dump job. The customer's maintenance and repair bills soon reach a point where he damns everything of the same brand name as his equipment. Consequently, the dealer has lost a repeat customer, as well as numerable word-of-mouth, or neighbor prospects from the original sale.

To get our potential customer off on the right foot, we endeavor to demonstrate our equipment on the grounds where it is to be used if at all possible. Equipment "Field Days" are nice and showy -- and also expensive for all of the dealers -- but the usually ideal conditions are not representative of our prospect's own turf areas. If, by some chance, we do not have the proper equipment to do a particular job -- and this has happened -- we will suggest that the prospect contact one of our competitors who does have the right machine. We do not believe in making a sale just to grab the customer's money when he is ready to spend it.

Once our customer has bought a new piece of equipment, we try to familiarize him with its operation and maintenance. Even such a minor detail as neglecting to remind him to open the fuel tank valve can cause unpleasant relations, and lost man hours.

In the capacity of liaison men, it is our obligation to pass on to the factories the criticism of our customers, whether it is complaints or constructive. We have had a good example of this last year in regards to the fast operating speed of a certain piece of our equipment. One of our local superintendents did some experimenting with this particular type of mower. The result of his work was so successful that we hounded the factory engineers to take notice. This year's mowers incorporate the change as standard, and according to the sales literature its the hottest thing out since the Mambo. Unfortunately, no mention is made of the superintendent responsible.

We really do like to hear our customers say, "Why doesn't the factory do this, or do that?" We'll pass on the suggestions, usually after we have tried making the change on a test piece of equipment of our own. One point must be kept in mind -- mowing equipment, or fertilizers, or turf chemicals, are mass produced for the entire country. Allowances for individual area conditions are not economically possible. This is so even in various strains of turfgrasses. So, sometimes we have to be satisfied with something less than perfect for our own use, because it is designed for forty-seven other states.

Serving our customers means that, should their equipment break down, we can get them back in operation in the shortest time possible. We, as well as our competition, try to maintain an adequate inventory of parts at all times. This is a much larger and more expensive part a distributor's business than most customers realize. The average large dealer in our field will have between \$ 5,000.00 to \$ 10,000.00 worth of parts on hand for just one of his lines of equipment. Many dealers handle a half dozen or more lines requiring such a parts inventory. Due to the nature of turf work, most equipment overhauling is done during the winter months, meaning that the dealers parts stock is heaviest during the Federal and State taxing period.

We make it a practice to keep spare engines on hand for the most popular equipment so that we can put them on a customer's machine, enabling him to keep mowing. We also have a demonstrator greensmower ready to loan a customer while we repair his. Along these lines, it is our shop policy that the flow of work is interrupted for only two things -- first: warranty work for any of our customers, and second: equipment belonging to golf courses.

Last year we experimented with a new means of offering service to our customers. All of our trucks and our salesmen's cars were equipped with special radio receivers with a range of about sixty miles. Should a customer have a breakdown, he merely called our office, gave the details and our office would call for the nearest truck or salesman to pick up the equipment if it was practical. This arrangement worked out quite well. At present we are investigating the use of two-way radios with a greater range. The preliminary prices we have received so far would indicate that we'll go back to smoke signals and carrier pigeons.

Another way in which we try to be of service is to pass on to the superintendents new information which we have read, learned from our suppliers, or observed. To check our supplier's claims, we try it out ourselves. If it works for us, we can sell the item with confidence. Otherwise, we are apt to be rather reticent in discussing the product. We firmly believe in this type of approach to selling. We are comparatively new in this field, and unless we can acquire the confidence of our present and prospective customers, we will have a tough row of beans to hill.

We establish friendly relations with greens committee chairmen. As most of you know, greens chairmen are rotated in office all too frequently -- the average term is only one year. Although the chairman may be a very successful business man in his own field, his knowledge of what it takes to maintain a golf course generally leaves much to be desired. We were quite pleased at the number of chairmen who stopped by our place last year. They came in not to buy anything -- darn it -- but to ask questions regarding equipment or fertilizers, or regulation golf poles, so that they could understand their superintendent's problems more fully. We most always were able to get a word in about financing their super's trip to the Purdue Conference, or the National Conference, or pay his membership in the National. We also mention the lack of job security that the average super has, as well as the comparatively low pay scale for the profession. We can be of some service in this manner.

A few points also applicable in serving our customers -- Our mechanics and salesmen are periodically schooled by the various factory engineers. This schooling covers servicing the new equipment, as well as improved methods for maintenance of the older types. Whenever we know far enough in advance that a factory engineer is coming in, we try to invite not only our own dealers, but as many of the golf course maintenance men that we can reach in time. There are no secrets in service.

The last point I would like to bring up is why we dealers attend Conferences such as this. I believe I speak for all dealers when I say that this is another way in which we try to serve our customers. Since each superintendent cannot attend all the discussions that take place at the same time, we peddlers listen in and take notes, mental or otherwise. Then, later on when someone asks what did Dr. Zoysia speak about, we may have the information desired. Also, we can pass on our observations to the fellows who were unable to attend the Conference.

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TECHNOLOGY IN SALES

Jess Taggart, Sales Service, Nitrogen Division,
The du Pont Company
(Presented before Turf Material distributors of M.R.T.C.)

This subject is fascinating for it gives a title to an important part of the job so many of us are trying to do. It is a major tenet of service selling. It is quite different than inspirational selling. And, it certainly is a contribution to truth in selling.

We all realize that the salesman of today must have, in addition to the ability to create desire, the knowledge to substantiate his claims. Allied with his ability to recognize need must be a talent for demonstrating mechanical or chemical value. The only conceivable reason we should discuss the technical approach to sales is to see how well we are doing the job; to judge our progress in approaching and satisfying the demand of our customers for technical help -- thereby, selling them our ideas and the products associated with those ideas. We must find if we have learned enough to really present the technical characteristics of our products.

Many years ago Plato, the Greek philosopher, presented a plan for the Ideal State. It was a wonderful plan that encompassed all phases of life. He said that the training should be a logical development from one phase of learning to another, with the goal an ability to contemplate the infinite source of existence and knowledge.

The course of training was likened to a ladder. The first rung was, say, reading and writing. The next was physical and animal sciences. Then came mathematics. Step by step the more difficult calculations were mastered until a man became less and less attached to the physical. Exercises in philosophy followed until, with years of thought, the mind could leave the limitations of the body and reach communion with the eternal.

My point, in recounting Plato's plan, is to indicate that continual and hard study is necessary to improve and to develop. Study of sales techniques is part of the job. Study of products is another. And, finally, in study of needs, we find the greatest possibility of success.

Let's set up our own ladder then. Study of sales techniques comes first. We must learn this skill before all else. Public library shelves are crammed with books on selling. Experienced men are happy to tell of their methods. Our daily contacts afford opportunity to observe what works and what does not. Short courses in selling, often company-sponsored, are good, though too often they are ignored as being superficial training.

Second step on our ladder will be study of products. We must know them well. Every part of their make-up, every nut and bolt, every chemical, every modification and improvement. And we should know our competitors' products just as well. Our association with these products must be so complete that our thinking about them is completely clear and our description of them lucid. In this fashion we gain for ourselves a sales edge and also approach the desired end point of best help to our customers. I have known, and I'm sure you have known too, salesmen with such a thorough knowledge of their product and of the industry or process in which it is used that this knowledge alone, plus an agreeable personality, helped to make them top salesmen.

The next rung on the ladder is study of needs. But, a great deal of time must be spent on rungs one and two before we are qualified to make this next step a sure one. Sales technique we must know to determine if an idea is sales worthy. Technological background we must have to recognize need and find the product or idea which fills the bill.

But, once we have qualified as creative salesmen who are able to find or develop products or ideas which provide a better way for our customer to do a better job, we will succeed. Our customers' benefit is surely our own.

So, technicological selling must be built upon sound knowledge of sales techniques and product characteristics. And the degree to which we are able to approach creative selling, as Plato's citizen approached the infinite, will be pre-determined by the depth of our study and thought.

An example of this plan in action may be our own system in du Pont. Young men, with good technical background, are hired just out of college or the Army. They enter into an extensive indoctrination which lasts about one year. Part of this time is spent in a rigorous study of sales techniques; they are introduced to applied psychology -- just plain understanding what makes a customer tick. A lot of time is devoted to our products -- all of them, for the man has not as yet been assigned to a sales section. He listens to experienced sales and product men speak of competitive products, and tough sales situations.

Finally, when our man has completed his preliminary training, he is ready to face the customer and equipped to think in terms of his customers' needs. He is on the road toward an ability we want -- the ability to reach beyond the bounds of day-to-day, bread-and-butter sales, to the realm of creative selling. However, this training doesn't stop there -- it is continuous and intensive! We need to be "refreshed" regularly.

Well, we have discussed an ideal. Many of us cannot disregard the bread and butter. It is fine to consider the heights -- we want to plan so we may achieve the heights -- but day-to-day problems are here. Can we compromise the ideal with the necessary? What is the practical combination of technology with sales?

At the onset we must start with a product and a program and a plan that are technically sound. You must offer the right solution to your customer's need. This sounds so completely elementary that to say it is unnecessary. But, this is the area in which a pseudo-technical analysis of a situation can serve as a great disservice to our customer. For example, in "Uramite" fertilizer compound I have a technically sound product to offer. Yet, if I compromise this technically sound product with technically unsound advice, as to its use or results which may be expected, I have done a disservice to both my customer and myself.

Make sure what you have fills a need. Remember that your success will vary in direct relationship to your customers'. The right product for the wrong job is as bad as no product at all. And, if there is no need, don't dismay. Use that creative ability you have developed. Think of the one-time "luxury" items that now have become necessities. In short, create a need looking for new applications of your product. The seller of rotary seeders might find his market was off during the winter. Perhaps he could sell the same piece of equipment for spreading sand or salt on the ice. He certainly has sold the same piece of equipment for distributing fertilizer.

Let me conclude with re-emphasis that the backbone of a good sales effort is study. Study of how to sell; of what we are selling; of how the product may be used. This study will lead not only to a better job of selling to conventional uses, but will be the means of making us idea men as well as salesmen.

SOME GEOLOGY OF OUR MIDWEST

W. N. Melhorn, Dept. of Civil Engineering
Purdue University, Lafayette, Indiana

The average layman, if asked to define a geologist and tell what he does, probably will mumble something to the general effect that he works with rocks or minerals. True, the geologist traditionally restricted his efforts to exploration for petroleum or metallic ores, and of course most of us are still employed commercially in these fields. In the universities, however, we discover quickly that geology plays a part in almost every aspect of natural phenomena. We are constantly amazed by the multitude of new applications of geological science. Because we are consulted so often by specialists in engineering, chemistry, physics, botany, agronomy and soils, to mention a few, we become "educational tramps" and must possess at least minimum knowledge in all of these allied fields in order to accomplish any mutual interchange of ideas about practical problems that arise.

Let me illustrate what I mean. Many of you are ardent sportsmen. An article appeared recently in a leading outdoors magazine* concerning distribution of ringneck pheasants in Southern Indiana, and also down east in Delaware and Pennsylvania. Some particularly observant hunters had long known that pheasants were plentiful in country where soils had developed on limestone rock, but were scarce where soils developed on other rock types, like sandstone and shale. The Patuxent Research Station of the U.S. Fish and Wildlife Service finally investigated this, and decided the hunters had been right all along, and that character of the soil and underlying rock definitely did affect distribution of the pheasant population. Now, I am not suggesting that you turn all your golf courses or athletic fields into wildlife refuges, but you can grasp readily the point that geological conditions influence many aspects of our everyday life without fully realizing it.

The title of this talk is in your program as "Some Geology of Our Midwest." This is the type of generalized title a speaker loves because it gives room for all kinds of evasive action and prevents being committed to discussion of any specific subject. Every appearance before a new group is a new challenge, because the major problem is to find one particular phase of the many diverse branches of geology that will be attractive to people like you who are primarily interested in soils, seeds, or plant nutrition.

I believe what we want to talk about today is the ubiquitous mineral called water. Yes, water is a mineral, for it not only meets the scientific definition of a mineral, but we literally mine it for consumption just as if it were iron ore or coal, and geological conditions at any particular spot are what govern its occurrence and availability. You all know that today we are not always able to find, produce and economically exploit all the water wanted in places where it is most needed. Many mid-western areas are experiencing an acute pinch in water supplies, particularly underground waters. Even where groundwater is presently plentiful, we are drawing on the underground storehouse of the ages and removing the water mineral faster than it is being replenished by natural agencies. Surface water from streams or lakes is sometimes available, but groundwater has

* Outdoor Life, February, 1957

a distinct advantage because of more constant temperature, better and more uniform chemical character, and dependability of flow throughout the year. Many of you are concerned with water usage for sprinkling, and are therefore irrigationists in the same sense as the farmer who irrigates a potato field during growing season to increase size and yield of his spuds. It may surprise you to know that about 10 billion gallons of water a day is used in the U.S. for sprinkling or irrigation and comprises half of the total daily national consumption. Agriculture, industry and domestic consumption constantly increases and creates demands for new supplies. We probably have water reserves to meet these demands, but because geological conditions underground determine where more water will be found, and because these conditions vary greatly, here is where geological knowledge enters the picture.

Most of our Midwest, that is the region between the Ozarks on the west and Appalachians on the east, the Ohio River to the south and Central Wisconsin to the north, belong to one geologic province. By this I mean the entire region has certain common characteristics; the rock types are similar and the whole region is covered to greater or lesser extent with unconsolidated clays, silts, sands and gravels deposited by glaciers of the great Ice Age that swept southward out of Canada in a series of forward advances and retreats, commencing about one million years ago and lasting until about 25,000 years ago in the southern part and 10,000 years ago in the northern part of the Midwest. Because of these common characteristics, Indiana can be used as a geological example for the entire region, and you representatives of other midwestern states can be assured that similar conditions prevail in your respective states, although, of course, there are numerous minor local departures or variations from the general pattern I will outline.

These pictures depict Indiana history over a period of time that spanned millions of years. In the beginning, shallow seas covered the state for a long era of time, and sediment washed into these seas from adjacent landmasses in the Ozarks, Northern Wisconsin, and the Appalachian Mountain areas. These sediments were originally lime muds, sand, silt and clay, but they have long since been compacted and transformed into hard, durable rocks, such as limestone, sandstone, siltstone and shale.

When the ancient seas finally departed from the Midwest, atmospheric agencies were able to operate for an equally long era of time on the nearly exposed land surface, weathering the rock materials into residual soil. Where developed on limestone rock, this soil was rich in soluble carbonates and other nutrient material, but where developed on shale and sandstone, the soils were mineralogically and nutritionally poor. If we had lived in these days prior to the Ice Age, our water problems would be extremely critical indeed. Much of the Midwest underlain by shale and limestone rock was unfavorable for groundwater storage then, just as these rocks are today where reached by the drill. Only in some areas of sandstone rock, such as Southern Wisconsin, Northern Illinois, and Southern Michigan would plenty of groundwater have been available. Even today many communities, industries and households in these areas obtain their water from these ancient sandstone rocks.

The coming of the glaciers either modified or completely obliterated the former landscape and left the landforms that are found today in the Midwest. From the water resources standpoint, this rearrangement by the frigid fingers of the ice was more of a natural blessing than a catastrophe. The region was left under a blanket of inter-mixed gravel, sand and clay,

pulverized into this form by the ice as it overrode the bedrock surface beneath. In many places the glacier filled stream valleys cut in the old landscape with a thick deposit of sand and gravel, which, because of their porous nature and the relative ease with which water will percolate through them, provide us today with many of our productive and potentially productive underground storage reservoirs. The position and course of some of these buried valleys is well known, but in other midwestern areas their meanderings have not been clearly defined. One of these ancient river systems, called the Teays River, lies beneath the Purdue campus and fills a buried valley with sand and gravel to a depth of nearly 400 feet. This prehistoric stream, perhaps as large as the modern Ohio River, also extends across Central Ohio and Illinois. As more is learned about its exact course and nature of its valley fill, it will be possible to more fully exploit the water it contains. Similar glacially filled valleys are known or will be discovered in the Midwest, and with passage of time will contribute more water to augment dwindling supplies now suffering from increased demands by cities, industries and individuals.

In conclusion, I will illustrate how glaciation has affected your choice of sites for golf courses, athletic fields, and the like. For example, where the ice paused long enough in its advance or retreat to pile up sand, clay, or intermixed sandy clay in high, irregularly shaped mounds or ridges, it left a naturally rolling terrain ideal as a site for golf course construction. Conversely, where meltwaters from the ice front laid down a natural, smooth apron of sand, gravel, or silt, you are left with a flat, well-drained site ideal for location of athletic fields or cemeteries. There are exceptions to this rule-of-thumb, but in general you will find that I am correct. You see geology has influenced you all along, but you never realized it until now.

WHAT IS YOUR PROGRAM?

Leo J. Feser, Owner-Manager
Orano Golf Course, Minneapolis, Minnesota

(Presented before Golf Course Section, M.R.T.C.)

The word "program" as used here is defined as a plan of procedure. To proceed, we must advance, move forward or progress. It is safe to assume that all intelligent individuals are thinking more or less constantly about their plans to progress and move forward to a more pleasant and satisfactory phase of life, but in this discussion we are particularly interested in those plans as they may concern Golf Course Superintendents. There are, no doubt, many principles upon which programs of this nature may be based, but it appears that progress is something very mutual; it is practically impossible to move forward alone. Not only is it necessary to think of our fellow-superintendent in our planning, we must think of our employers, not just those who are paying us, but the broad field of those who seek recreation and pleasure in golf.

If we take the stone aggregate of natural resources, the cement of technology, the waters of energy and mix them with the strength of faith, we can cast a solid base from which progress can be made in any field of endeavor. In the field of endeavor, I like to think in terms of two great ranges. The first of these is the field in which we earn our daily bread in the form of wages or salaries, and the second is the range in which we disburse of those earnings. Let us call these divisions the "earning range" and the "living range." Progress in one of these ranges does not necessarily mean progress in the other. As golf course superintendents we are inclined to devote so much of our time and energy to the earning range that we fail to make desired progress in the living range. He is wise who knows how to balance his efforts so that he makes progress in both ranges.

In Louisville a short time ago, we had a panel discussion of the superintendent's responsibilities. As these responsibilities were brought out and discussed, I had the confirmed feeling that there was enough to this job to take up all of our conscious time. As I know and have known superintendents all over America, it seems that many of you have let yourselves get into just that position. One of the many pleasures that I have experienced in attending the various meetings throughout the country has been meeting and knowing a number of wives of the superintendents. A grand and wonderful group of women. Among their many virtues I am sure that patience must be an outstanding one. Patience with you men who are inclined to dedicate yourselves too completely to your jobs. Too completely to the earning range at the expense of the living range. Don't forget that your wives and families have a big claim on you, a claim that applies to your living range as well as to your earning range.

There are many incentives that pull a man along the road to success; interest in work, satisfaction of ambition, pleasant experiences in the range of earning, a sense of duty, and no doubt many others. Of all incentives, I believe that wages and salaries are the most tangible. I am going to urge you to seek a greater paycheck, and I am going to try to prove to you that this should be a very definite part of your program; a greater part of your plan for progress. I am further going to attempt to prove to you that by so doing you will best serve your employers, the people of America who buy recreation in the form of golf.

Let me repeat --your employers, the people who buy recreation in the form of golf. Add the other recreations that your services assist in providing, and you add to the number of your employers and to the salaries that you should receive. Let us not kid ourselves by any false sense of our own importance. We have no shadow of a claim that simply because we are in a low income bracket, and that we are doing a fair job, we have the right to confront our committee with a demand for more money. We must be aware that if any one of us breaks his neck or succumbs to those ulcers, golf and recreation must and will continue to be served. The show will go on. It is going on right now, and golf is already paying a bill that is higher than it might be.

There are less than 2000 qualified superintendents in America today, serving a population of well over 165,000,000 people. If you disagree, just look at the membership of the National Association. You will find that there are approximately 1000 members of that group, covering United States and Canada. These are the men who take their profession seriously enough to belong to a great and sole association dedicated to the advancement of golf

maintenance. I am in no position to judge any man on this matter, and I have no doubt that there are some who may have valid reasons for not belonging to our National Association, tho I confess that it is difficult for me to think of any of those reasons. But, I will be very generous and say that there can be one qualified superintendent outside this organization for every member of it, and the answer is about 2000.

These figures show that every qualified superintendent today serves approximately 80,000 people. If only one of 20 of these is a golfer, it means that the superintendent is serving 4000 golfers. Remember, I am referring to those 2000 qualified men, because that is important in our study. Of course, I suspect that less than one out of 20 of our population is a golfer, but what about tomorrow? With our schools bursting at the seams, with earlier retirement for workers, and with more leisure time for all people, do my figures seem out of line? A membership of 4000 people in any club would give the superintendent something to worry him beyond the call of duty, and this will never become a common thing, but the problem can be cared for only by providing enough golf courses, and equally important trained men to maintain these courses.

A year ago at Minnesota, I stated that the golf courses of America suffered annual losses, in excess of \$ 1,000,000.00, because of errors made by the golf course superintendents. Perhaps that was much too conservative. Let's take another look. At Louisville we discussed the 12 areas of the superintendent's responsibilities. Let's look at just five of these areas: Area Maintenance, Structure Maintenance, Equipment, Personnel and Materials. What of my own experience in these areas? For 30 years, until my retirement in 1951, I was the superintendent at a Minneapolis club that was noted for its business administration as well as for its excellence as a country club. We had a tight operation. Yet, as I look back, I realize that I wasted some of their money. Say I wasted by error the total of \$ 100.00 in each of the five areas, a total of \$ 500.00 a year. If you think I was careless, just remember that I have had lots of time to look back and to think over some of those errors. I tried to have an efficient operation and made more than a passing effort to keep abreast of the times. What would an untrained man, working under ordinary committees waste? Twice as much? Ten times as much? But using a conservative basis of five times that much, we come up with \$ 2,500.00 a year.

There are about 5000 golf courses in the country today, and if we have 2000 trained men to operate them, the 3000 remaining clubs are paying an annual bill of \$ 7,500,000.00 for services that they are not getting! I think that calls for some course of action. At Louisville one of the speakers told us that if 1% of the total amount spent on maintenance was set aside for research, \$ 1,000,000.00 would be made available for that essential work every year. I contend that even now we are so far behind our research people that we can't see their clippings. But, we haven't got any where near enough trained men to apply the facts that are already well known.

Can golf today compete in the market that is crying for engineers and professional men? I am sure that it can provided that we can eliminate some of the ideas of ridiculously low salaries and the waste that a lack of business sense incurs. Eliminate the waste and raise the salaries of 5000 superintendents an average of \$ 1,000.00 a year, and there will be enough

left over to give our research people not one million, but two and one-half million dollars annually, and it won't cost the golfers of American one additional dime! Now, note carefully that I said eliminate the waste. Raising salaries alone won't do it, but it will help to attract men into the field who will be able to cut down that waste.

I further contend that you men are partly responsible for the picture as it now exists. In my opening remarks I stated that it was practically impossible to move forward alone. We have to think of the other fellow; our friend who is in charge of maintenance on the other side of town, our employers who have certainly been taking it on the chin, and we must think of those who are near and dear to us, our wives and families. We must think more of our living range, with a full realization that our pursuit of happiness is somewhat dependent on the size of our paycheck. We had better think of our own efficiency as well. If we are holding our jobs simply because the profession does not offer enough compensation to attract more competent and better trained men, we might as well apply for the job of mowing greens. If we are competent, if we are producing top results on an efficient basis, we needn't be reluctant to demand proper compensation.

Of course, I know that the wise committeemen and superintendents have already figured this out. Many clubs are now paying very good salaries, and have obtained very good men. This is as it should be, but it doesn't excuse any of us from facing up to the facts. That facing of facts should and must be a very basic consideration when you answer questions on, "What is Your Program?"

MILITARY TURF USES

Burton F. Kiltz, Dept. of The Army
Gravelly Point, Washington, D.C.

(Presented before General Turf Section of M.R.T.C.)

The needs of the military services are at times different than the needs of other agencies who maintain turf. Some of the basic differences relate to the size of the average installation and the relatively small crews that operate them. The average Army installation comprises approximately 3200 acres of which 800 are lawns, ball fields, parade grounds, and the like. On a year-round basis, approximately seven men maintain these areas which includes supervision of agricultural leases, woodland management, mowing and constructing fire guards to prevent fires, maintenance of the improved grounds, landscape plantings, cleaning brush and aquatic weeds out of ditches, and many others.

To furnish these services, the military departments are forced to use many devices to economize. Many installations, because of this austerity, are not well supervised. We wish that they were better advised and more closely supervised than is presently possible.

The following policies are listed as examples of Army opinion relating to grounds maintenance activities and are widely accepted in military circles as means to get the greatest possible benefits from the least possible out lay. These policies are not new. Most of them have been recognized for 10 to 15 years in various degrees of acceptance.

1. Maintenance fertilizer rates are relatively low. This has two objectives: to reduce the cost of materials and to reduce the number of times turf must be mowed. This policy does not apply to athletic areas and to seedbeds, which normally receive heavy fertilization.

2. Cutting of turf is relatively high, usually one to one-half to three inches. Objective is principally to permit rapid mowing with tractor mowing equipment and thereby avoid scalping, need for topdressing, and damage to mowers.

3. Adoption of new strains of grasses is slow. Many new species have been discovered to be expensive to maintain.

4. Austerity in landscape plantings, especially shrubs has long been an Army policy to permit more economical maintenance of its grounds.

5. Simple seed mixtures are preferred. Only one or two species on any site tends to persist into maturity.

6. Grading of new lawns at one-inch below sidewalk grade has recently been advocated.

7. V-shaped trenches are opposed along walks and drives.

8. Wooden fences, rows of rocks, battalion emblems and similar "improvements" are discouraged.

9. Elevations on new lawns should be established by instruments, not by eye. The correction of drainage after planting has been an expensive substitute.

10. Areas planted for dust control should be excluded from all foot traffic. This is principally a Western states problem.

11. Topsoil has been used in excess of its requirements for establishing new lawns, and, in general, the practice is opposed.

12. We believe simple plot tests are superior to laboratory tests for determining which fertilizer to use.

PRODUCING SOD

W. H. C. Ruthven, Alliston, Ontario
(Presented before Sod Nurserymen Section of M.R.T.C.)

It is a great pleasure to be here with you to discuss the growing of nursery turf. This is the fourth year I have terminated my holidays down south to enable me to attend this Turf Conference at Purdue.

Last year I stated that I believed Merion Bluegrass sod could be produced in one year by using proper fertilization methods and irrigation. Now I can definitely state that after seeding August 20, 1955, a very excellent sod was ready for lifting by mid-July 1956, and this was accomplished without irrigation. We were, however, favoured with a liberal rainfall during the spring and early summer.

In the spring of 1955 on a newly purchased farm, the following technique was followed in a twenty-acre field of a stone free sandy loam soil. Part of the field was stubble ground and the rest was seeded to a hay mixture. About the first of June, we cultivated this field with a Graham Holme nine-tooth heavy duty cultivator. The field was cultivated once cross-ways, and twice on an angle in opposite directions with a couple of days lapsing between each cultivation. A ten-foot double disc was used at intervals of three to four days. The field was then cultivated with an ordinary farm cultivator, and diamond steel drag harrows were used until seeding time, August 20. An application of super-phosphate fertilizer, (20%) was applied with a regular fertilizer spreader, eight hundred pounds per acre, and disced into the soil in mid-July. Just previous to seeding time, a balanced fertilizer, 10-10-10, was applied at 400 pounds per acre. The ground was then harrowed and ready for seeding.

Twenty pounds of Merion Bluegrass seed was sown per acre, using an eight-foot Brillion seeder with just one single seeding. The seed germinated very nicely and was quite green by September 20. However, there must have been a lot of mustard seed in the soil, and by October 20 we had a heavy stand of mustard towering eight to ten inches above the Merion Bluegrass. Such was the appearance of the field that a neighbour inquired if I was going in the cattle business -- I had such a nice field of rape.

We tried a single cut through the field with a five-unit Blitzler Mower. But, there was so much green tossed salad material that the cutting would have smothered the grass. Two days later we sprayed the field with a very light application of 2,4-D, using one and a half Imperial gallons on the twenty acres. Five days later, the mustard weeds had a drooping effect and it looked like a field of sick chickens. However, this evidently proved to be an ideal nurse crop for the grass as it held a nice even amount of snow on the entire field. The remnants of the mustard plants protected the grass from the cold spring winds, and after the first cutting, the weeds completely disappeared and the grass grew very rapidly. Early in May we made an application of one hundred and fifty pounds of pelletized urea 45% nitrogen fertilizer, and a similar application was made again in mid-June. When Professor Musser visited this field early in July, he made the statement; "Bill, you have had Florida growth in the production of this Merion Bluegrass." During the height of the growing season, the grass had to be cut every five or six days. The cutting was done with blitzler type

mowers to a height of one and a half inches.

A good spraying program is essential in the production of top quality weed-free turf. Merion bluegrass is more tolerant to spray materials than other turf grasses. Consequently, the weed problem is lessened.

For better turf production good common sense should prevail and the timing of operations is an important factor. All equipment must be in good order for fertilizing, spraying, cutting and seeding. Since weather conditions, especially rain and wind, affect these operations so much, it is very important to get a detailed early morning weather broadcast giving temperature, wind velocity and probable rainfall. This information will be quite valuable in planning your work for the day. Seeding operations especially can be held up with too much moisture or excessive wind, and thus it is well to have your tractors equipped with good lights as the best time for seeding is often from five to eleven P.M.

When I first thought of growing turf seven years ago, I received a great deal of information and guidance from turffarmers in the vicinities of Detroit, Chicago and Washington, and from the turf projects visited at Beltsville, State College and East Lansing. Since that time I have been privileged to attend many excellent Turf Conferences, including the very instructive meetings conducted by the U.S.G.A. For all the courtesies and splendid cooperation received from these different sources, I wish to express my sincere thanks and gratitude.

PROBLEMS IN GROWING SOD

H. B. Musser

(Presented before Sod Nurserymen Group of M.R.T.C.)

Soil. The first, and probably one of the most fundamental problems in sod production, is the selection of a soil that is suitable for the operation. One necessity is that it be reasonably free from stones that would interfere with cutting. A deep, well-drained sandy loam is considered the most desirable soil type. Such a soil should have a reasonable quantity of silt and clay in it to prevent excessive droughtiness and hold nutrients. On the other hand, it should contain a sufficient amount of coarse sands to permit the easy movement of moisture through it so that it will dry out and warm up readily in the spring.

Lime and Fertilizer. One of the important economic factors in commercial sod production is to mature it as rapidly as possible. The grower cannot afford to run the risk of slow development because one or more essential nutrients are so low as to be limiting growth factors. This is true also with respect to acidity levels. Prior to seeding, a good quality complete fertilizer should be applied and worked into the soil to a depth of at least three or four inches. Soil acidity levels should also be adjusted by applying lime wherever soil tests show acidity appreciably below pH 6.5.

Seedbed Preparation. Seedbed preparation and seeding also play an important part in rapid turf development. The good sod grower finds that it is important to do a thorough job of tillage to a depth of at least four or five inches. This can be done on light sandy loam soil by thorough disking followed by harrowing and smoothing. Heavier soils may require plowing and more intensive fitting operation.

Seeding. Methods and rates of seeding can be varied widely, depending upon available equipment, the kind of grass or mixture used, and how fast cover is needed. Where hopper seeders are used, which deposit seed on the surface, some method of shallow covering, followed by light rolling, is desirable. Seeding equipment that distributes the seed, covers and firms the soil in one operation usually is the most satisfactory.

The quantity of seed applied per unit of area will depend first upon the kind of grass or the mixture used. A fescue seed is about three and one-half times the weight of a Kentucky bluegrass seed, and so fescue seedings must be approximately that much heavier than bluegrass to secure the same stand. Kentucky bluegrass is about $2\frac{1}{2}$ times as heavy as bent and so must be seeded at a proportionately heavier rate than the bentgrass. When mixtures are used rather should be adjusted according to the percentages of each kind of seed in the mixture.

Seeding rates also will vary, depending upon the condition of the seedbed, time of seeding, uniformity of distribution and how fast a cover is needed. If seedbeds are weedy a quicker and more dense cover will be needed than where it is not anticipated that weeds will be a problem. When seedings are made in the early fall under good conditions of soil temperature and moisture, rates can be lower than under less favorable conditions for germination and establishment. Under ideal conditions it may be possible to secure good results with seedings of Kentucky bluegrass as low as 12 to 15 pounds per acre, or proportional amounts of bentgrass and fescue. For average conditions rates normally should be three to four times as high.

Seed quality also influences seeding rates. Purity and germination figures materially affect the quantity of seed needed to produce an adequate stand. Where these quality items are low, rates must be increased proportionally.

Maintenance. The type of maintenance given commercial sod will depend primarily upon when it is to be lifted. If it is to be matured and cut as soon as possible, it will be necessary to follow a much more intensive maintenance program of clipping, watering and fertilization than if it is to be held on a stand-by status.

When Kentucky bluegrass and fescue are to be marketed as soon as possible, they should be clipped regularly at a height of $1\frac{1}{2}$ to 2 inches, watered during drouth periods and fertilized at least once between seeding and sod cutting. If seeded in the early fall, they should be re-fertilized during the cooler weather of the following season with a minimum of two to three pounds of nitrogen per 1,000 square feet and at least one-half this amount of both phosphate and potash. When spring seeded, a similar application should be made the following fall. Merion Kentucky bluegrass will respond to even larger quantities of nutrients.

Bentgrasses should be fertilized similarly, but they will require more water in drouth periods and should be clipped frequently to a height of not more than 1/2 inch.

Where seedlings of Kentucky bluegrass or fescue are made two years or more before marketing the sod, it is not necessary to practice intensive maintenance on them until the season immediately prior to cutting. Unless clipping is necessary during the seedling year because of weeds, they can be permitted to mature and set seed without mowing. After seed has matured they should be cut and the straw raked off. At the beginning of the season, prior to the time the sod is to be cut, they should be given the same type of intensive maintenance outlined above.

Bentgrass cannot be handled in this way. It must be mowed, watered and fertilized regularly if a good firm sod is to be produced.

Harvesting. Sod can be harvested as soon as it has knit sufficiently to permit handling without excessive loss. Under favorable growing conditions in the cooler sections of the cool, humid regions, sod sometimes can be cut when ten months to a year old. Where conditions are less favorable two growing seasons usually are necessary to produce good quality turf.

The advent of the power sod cutter has radically changed the methods of cutting and handling sod. The modern practice is to cut strips 12 to 18 inches wide and from 3 - 9 feet in length. The strips usually are rolled or folded several times for convenience in handling. Where accurate measurement for payment is necessary, a convenient strip length for a 12" wide strip is 54". This contains 1/2 square yard and permits easy record keeping by counting the rolls. Similarly, an 81" long strip that is 16" wide contains one square yard.

Thickness of the cut sod is an extremely important consideration. A difference of 1/4 inch in thickness of cut requires the handling of approximately five additional tons of soil per acre in loading and hauling the sod. This is equivalent to an additional 25 to 40 yards of sod in every 400 yard load.

An item of equal importance is the fact that thin sod handles more easily, lays better, and knits faster than thick. When a large quantity of soil is retained on the roots, they have a tendency to stay in this layer and will not grow down into the prepared bed as rapidly.

Kentucky bluegrass and fescue sod cannot be cut as thin as bentgrass or other forms having surface runners. Good quality bentgrass sod maintained at putting green height often can be cut at a thickness which will not remove more than 3/16 to 5/16 inch of soil. It is seldom possible to cut Kentucky bluegrass or fescue sod without taking from 3/8 to 5/8 of an inch of soil.

SEEDING PRINCIPLES

H. B. Musser

(Presented before General Turf Group of M.R.T.F.)

The question of seeding rates for establishment of new turfgrass areas long has been one of the most frustrating and, at times, controversial items of the entire operation. Every seed company makes recommendations for its own products and many tables of rates for individual grasses have been published. The principal difficulty is that there is very little agreement among them.

Of course, the real reason for this diversity of opinion is that recommendations are based on experience under different sets of conditions. Many things affect the ability of a seed to germinate and produce a plant. The first step in determining how much seed should be planted is recognition and evaluation of the variables that can affect seeding rates.

But why worry about such things? Why not settle for a sufficiently liberal quantity that we will be sure to have enough? Of course, this is the philosophy followed by those who make recommendations for seeding rates of most any kind of grass or mixture at figures such as a pound per 100 square feet. Suppose such a rule is followed in seeding 50 acres of fairways. At present seed prices, using even one pound more seed per 1,000 square feet than necessary, would increase seed costs of the job by more than \$ 3,000.00. This is not the end of the story. Too much seed may be just as disastrous as too little. There is too much competition among the plants for moisture and nutrients and all are weakened.

On the other hand, where too little seed is used, we may encounter an intensified weed problem because of lack of competition. At the best, we have to wait longer than can be tolerated for the turf density and quality we want.

So, what is right? Factors determining seeding rates fall into two general classes. The first of these includes such things as good seedbed preparation, uniform seed distribution, proper covering and mulching. The second is concerned with the quality of the seed.

Good seedbed preparation is essential. Unless it is reasonably firm and fine, with adequate nutrients in the surface zone to support young seedlings, there are sure to be serious losses in stand.

The importance of uniform distribution is self-evident. There are so many good types of seeders on the market today that this should not be a problem.

Adequate covering is essential. Most of the trouble with covering usually comes from using equipment that deposits the seed on the surface of the soil. Unless it is carefully covered in a separate operation, stands are sure to be affected. Even where seeders are used that are designed to cover the seed, adjustments often are necessary because of soil differences. Most grass seeds can be planted in a light sandy soil to a depth of at least 1/2 inch. Don't try this on a heavy clayey soil that will form a surface crust.

Firming the soil around the seed is important. Certain types of seeders are designed to do this. If equipment is used that will not do it, seeding should be followed by light rolling.

Mulching is one of the best insurance policies against seeding failures that anyone can buy. There are various methods available ranging from the use of cut-back asphalt to covering with hay, straw, or similar material. All are designed to conserve moisture and prevent washing until the grass is established.

All of these things are important in affecting ultimate stands of grass. On the other hand, they are almost entirely within the control of the operator and so should not basically affect seeding rates. The character and quality of the seed itself is much more important.

How do we arrive at a base figure for seeding rates? The principal items to be considered are seed size, purity, germination, average mortality, and desired initial density. Seed size directly affects the number of seeds planted per pound. This may vary from 350,000 for ryegrass to over 7,000,00 for the bents. The purity tells us what percentage of a pound actually is seed. Germination gives us the proportion of the pure seed in a pound that are viable, as shown by their ability to sprout in the germinator. Average mortality is that proportion of the live seed that can be expected to produce plants when planted under favorable conditions. And finally, rates of seeding must be based on what we consider to be a satisfactory stand.

In examining these items, let's start with the last one. The following slides show seeding rates and stands obtained from 1, 2 and 3 pounds of bentgrass seed per 1,000 sq.ft. with the actual number of plants obtained per square foot. The interesting point in this connection is which of these stands would be considered to have adequate initial density. We concluded that the lightest rate was too thin and that the 2300 plant stand was thicker than necessary. At this point we interpolated and arbitrarily chose a stand of between 1400 and 1500 plants per square foot as the most desirable. This is the basis we use for seeding rate calculations.

We found, also, that the average mortality must be taken into consideration in determining seeding rates. This is the percentage of seed that the germination test shows to be viable, but which does not produce plants in the field. By averaging results of repeated tests, we have set up a figure of 30% for red fescue, 40% for bentgrass, and 50% for common Kentucky bluegrass. These figures are based on results similar to the following tabulation (Slide).

<u>Grass</u>	<u>Average number/sq.ft.</u>		<u>Percent of seeds producing plants</u>	<u>Percent accounted for by germ. test</u>
	<u>Seeds planted</u>	<u>Seed- lings</u>		
Ky. blue	3398	950	28	80
Red fescue	1253	677	54	90
Bentgrass	3816	1973	52	95

Since we know the purity and germination of any lot of seed from the label, it becomes a matter of simple arithmetic to calculate how much seed of any grass will be needed to produce a stand of 1500 plants per square foot. It works like this: (Slide)

<u>Grass</u>	<u>Seeds per lb.</u>	<u>Purity</u>	<u>Germ.</u>	<u>Survival</u>	<u>No. of seeds pro- ducing plants</u>	<u>Pounds* needed per 1,000 sq. ft.</u>
Bent	7,000,000 x	95	x 95	x 40	= 3,590,000	0.4
Ky. blue	2,250,000 x	95	x 75	x 50	= 791,000	1.9
Red fescue	600,000 x	95	x 85	x 30	= 339,000	4.4

*Based on 1500 plants per square foot.

This provides a figure on which to base a practical rate of seeding estimate. This is the minimum quantity of seed of the particular species or mixture that can be expected, under the best conditions, to provide a satisfactory stand. Whether it is actually enough is a matter of judgment. The poorer the conditions are for good germination and seedling establishment, the greater the modification from the calculated rate must be. Such modification, however, should be confined to reasonable limits. Increasing seeding rates cannot take the place of good preparation. If seedbed preparation and seeding methods are so poor that it appears necessary to use more than twice the calculated rate of bentgrass or bluegrass, or in excess of 1/3 to 1/4 more of fescue, it would be wiser to improve conditions rather than to try to compensate for them by increasing the seeding rate.

FAST TURF ESTABLISHMENT --
THROUGH THE USE OF MULCH AND HYDRAULIC SEEDING

Charles O. Finn, Finn Equipment Co.
Cincinnati 6, Ohio

(Presented before Parks, Industrial and Landscape Groups of M.R.T.C.)

In turf establishment we find there are three main categories for its use -

First: THE PLANTING OF GRASSES FOR SEED, hay and pasture which is the Agricultural side.

Secondly: THE USE OF TURF IN EROSION CONTROL work - for holding newly graded slopes and embankments in place. This is Highway, Soil Conservation Service, and Forestry Service work.

The third use of turf is BEAUTIFICATION. This covers parks, lawns, golf courses, playgrounds, industrial landscaping. Most of our work has been done in the second of these turf uses, Erosion Control. However, we see now these methods and equipment being used in all three types of turf establishment.

Our Company's interest in the turf establishment field goes back about six years when we built our first mulch spreader for spreading straw on highway work.

The next development was the use of asphalt emulsion with the mulch to hold it in place. This was followed by the development of the Hydro-seeder, and today our business is exclusively confined to Erosion Control equipment. I have here three slides to show some equipment.

The first slide shows a MULCH SPREADER in action on a typical highway slope, depositing a uniform coating of straw, which is mixed with asphalt emulsion to bind and hold it in place.

The second picture shows the HYDROSEEDER. This machine uses 1000 gallons of water mixed with a ton of fertilizer and 200# or 300# of seed. This mixture is churned to a slurry and sprayed onto the ground by nozzles which have a reach of approximately 100'. These two pieces of equipment have revolutionized the turf establishment methods of erosion control work in the past few years.

THE USE OF STRAW OR HAY MULCH TODAY has become more or less standard in highway construction work. A few years ago we decided to make some studies concerning the use of mulch. WHY is it USED? WHAT GOOD IS IT? HOW MUCH SHOULD BE USED? And, 101 other questions concerning its use. We could find very little recorded data as to the scientific reasons back of the use of mulch. In the first place, we found that it wasn't new. When Old Mother Nature was a girl, she used Eve's discarded fig leaves to promote planting in the Garden of Eden. Down through the centuries, successful gardeners have used mulch of different kinds.

In our search for information I happened to be in Washington, in the office of W.B. Ellison - with the U.S. Navy, Bureau of Roads and Docks Division. In erosion control he has used high speed Stroboscopic Cameras to record his experiments. He showed a single falling raindrop. When that drop hit the soil, it formed a crater. The water splashed out of this crater was laden with the soluble nutrients. These NUTRIENTS WERE CARRIED AWAY with succeeding drops of water. This gave us a clue as to what mulch really does, because a very small amount of straw over this soil broke these drops, reduced their kinetic energy to let the water filter in the soil rather than bouncing off and running away. This, I think, is the first highpoint in the use of mulch.

Second, when rain does fall on this surface, each straw provides a retaining dam for soil and water. In this DELAYING SLOWER FLOW, soil has more chance to absorb that water.

The third reason for mulching is the INSULATING QUALITIES that a mulched surface offers. It provides protection of the germinating seed against the direct rays of the sun. This is being borne out because the specifications on mulched areas are being changed to lengthen the planting

season to include more hot weather. This INSULATING process also works in cold weather - keeping the ground temperature more uniform, providing the germinating and growing seed with an ideal place to bring forth a strong and healthy plant.

Fourth, and equally important, the Mulch Also Slows down the absorption of the moisture back into the air in hot weather.

An interesting thing, fifth in this list, that we have noticed in spreading mulch on newly graded areas which might have some scientific importance is the fact that within two or three days after spreading mulch on an otherwise barren embankment, we find all sorts of insects - ants - at work setting up their new houses. This, of course, leads us to a FIELD OF MICROORGANISMS which is coming into the picture fast.

A sixth feature in the use of mulch is the reports that we got from places where they have a heavy dew fall where the SOIL UNDER MULCH ABSORBS enough water from the air to start and maintain growth without much regard to rainfall.

The West Virginia Turnpike brought to the attention of the general public that there was an easier way of getting growth established. Mr. M. A. Mendel, Landscape Engineer for the Turnpike, decided to use mulch with asphalt and the hydraulic seedong on the 88 miles of cuts and fills, winding through the mountains. Of course, the turf that was established is still doing a wonderful job of holding the soil in place.

This brings us up to the study of HYDRAULIC SEEDING. We have found that in hydraulic seeding, the slurry solution of seed, fertilizer, and water, breaks up and falls to the ground like rain. In the center of each raindrop is the seed. The seed is surrounded by the liquid solution of water and fertilizer. On falling to the ground, the nutrients so necessary for quick plant germination and growth are within easy reach of the tiny roots as they emerge from the seed hull. We believe that this is the secret of a fast growth that we get on hydraulically seeded areas.

A second thing with HYDRAULIC SEEDING, we find that water being the carrying medium of the seed, there is practically no segregation of the light and heavy seeds up to 100' because the water drops determine spread.

Another interesting thing with HYDRAULIC SEEDING is the fact that the water drop falling causes the seed to come in closer contact with the ground where it is not likely to be displaced by the wind. When this seed is covered with mulch, ideal conditions are produced artificially for its growth. We also believe that the small amount of water used in the hydraulic method of seeding assists in re-establishing capillary attraction of moisture in the soils.

Now some of the interesting results of the use of these methods and equipment throughout the United States:

1. We see lower costs of turf establishment through contractors bidding on highway and erosion control work.

2. We see the jobs of mulching getting larger and larger. Three to five hundred acre jobs are not uncommon.

3. A recent survey showed that straw and hay spread by our machines added a new farm income over a million five hundred thousand dollars for the straw. The Ohio Turnpike alone used seven thousand tons.

4. An estimate of the water saved from runoff by this turf establishment would be well in excess of two billion gallons.

NOW, LET'S LOOK INTO THE FUTURE A MOMENT. The pre-germination of seed and its planting with the Hydroseeder looks like one of the most fantastic developments in our work. It is so easy, just soaking the seed until it is ready to burst, then seed. The seed is ready to go to work immediately and even faster turf should result. Just think what this can do in the dryer areas by taking advantage of the moisture when it exists.

A lot of experimental work and study should be made along these lines. Dr. Daniel and his students at Purdue University are conducting tests now. Another use for the Hydroseeder is the spreading of friendly bacteria, more of which we are learning every day. 40 - 70 acres a day makes this operation awfully cheap. It is already being done with the legume innoculants. Another thing, we hope the Soil Bank program can be used as a resource for the supply of seed and mulch for the farm erosion control.

Now, you men are no doubt asking this question: Where does this fit my problems?

Well, the most of you are charged with the establishment and maintenance of turf of some sort. We believe that these methods offer an easier, faster and cheaper way of doing it. You have places where you want turf thickened. This can be done with a minimum of soil preparation with seed and fertilizer, fast and easy through the Hydroseeder.

Refertilization using large or small quantities of fertilizer, soluble liquid or organic can be applied evenly - fast and cheap - any time of year. We have developed our new Bantam which is ideal for smaller jobs.

Quite a number of you have sources of supply of vegetative mulch growing on your own areas. This can be used in turf establishment. We are willing to cooperate in any way possible to learn more in developing methods for cheaper, faster and easier turf establishment.

INSECT CONTROL IN TURF

Donald L. Schuder, Department of Entomology, Purdue University
(Presented before General Turf Group of M.R.T.C.)

Many kinds of insects are found in turf, but only a few are troublesome enough to require control measures either as a result of their feeding or burrowing. The following are those which may seriously injure or disfigure lawns, golf greens, and other grasses. Other insects, such as

the clover mite and diggers are nuisance problems.

White Grubs - White grubs are the larval stage of May beetles or June bugs, as they are often called. The adults feed on deciduous trees and are attracted to lights; therefore, their injury often occurs near wooded areas or lights. The grubs themselves are large, fat, white, curved-bodied insects up to one inch in length. They have hard brown heads and prominent legs. They feed on the roots of grasses and often become abundant enough to kill patches of turf. Grub injured turf will be loose and can be pulled or rolled back to expose the grubs since the roots have been eaten away. Most species require three years to reach maturity, but one, which is increasingly important, has a one year life cycle and is known as the annual white grub.

Japanese Beetle - The Japanese beetle is gradually spreading westward and is more and more frequently found in the Midwest. The adult stage feeds on many fruit and ornamental plants. The larval stage, like the common white grubs, feed on the roots of grasses. The larval Japanese beetle resembles our common white grub, but can be distinguished by examination of the gaster, the underneath side of the tip of the abdomen.

The Green June Bug - The adult beetle is a large, 1" long, beetle with velvety green wing covers and tan colored margins. The adults feed on many trees and plants and lay their eggs in decaying organic matter, such as piles of grass clippings. It is most common in southern areas. The larval stage feeds on organic matter in the soil, their burrowing uproots seedlings and causes injury which is most severe in dry years. Their burrowing also throws up enough soil to smother small plants. The larvae have the unusual habit of crawling on their backs.

Wireworms - Wireworms are the larval stage of the common click beetles, snapping beetles or skipjacks. The wireworms are hard, dark-brown, smooth slender larvae which bore into the underground parts of the stems and feed on grass roots. They are usually most troublesome in wet areas.

Mole Crickets - Are tan or brown-colored insects about 1 and 1/2 inches long. Their front legs are stout and shovel-like. The eyes are large and beady. They feed on grass roots and their tunneling uproots seedlings.

Rose Chafers - The tan-colored, spiny legged beetles feed on many ornamental plants, are most abundant in sandy areas. The grubs feed on grass roots, but are not as harmful as some of the previous species.

All of the soil existing and feeding pests can be controlled with several materials such as aldrin, dieldrin, chlordane, DDT and heptachlor, but chlordane is most common. Control lasts 3 years or more.

Ants - Ants, such as the citronella ant, build nests in lawns. The nests and mounds often smother the grass and some species systematically cut off all vegetation surrounding the nest. Control lasts 3 weeks or more.

Cutworms - Cutworms sometimes damage lawns, especially where there is dampness and rank growth of grass. The cutworms are dull-brown, gray-stripped, or nearly black caterpillars 1 - 5 inches long. They usually feed at night and remain hidden in the soil or clumps of grass during the daylight hours. They injure grass in the spring by cutting off the blades, leaving closely cropped brown spots in the turf.

Armyworms - Armyworms are the larval stage of common night-flying tan colored moths. They are about 1.5 inches long and have greenish or blackish stripes along each side and down the back. When they are numerous they devour the plants down to the ground. As they exhaust their food supply in an area, they march in armies from one feeding site to another.

Sod Webworms - Lawns composed of bent or young blue grasses are the most likely to be injured. The worms feed at night, live in protective silken bags and cut off blades of grass and drag them into their burrows to be consumed. Irregular areas of unevenly cropped grass are signs of their presence. Birds often do a lot of damage to turf when digging out the webworms.

Chinch Bugs - Most chinch bug damage is caused by the young bugs or nymphs which appear bright red. They suck the juice from the plants, causing them to turn yellow. The yellow spots rapidly become brown and dead. They are most troublesome on turf in southern areas.

Leafhoppers - Leafhoppers are tiny, mottled or speckled insects that fly or hop short distances when disturbed. Many species infest lawns where they suck the sap from the plants. New lawns are particularly injured by heavy infestations.

Spittlebugs - The nymphal stage often produces spittle masses on white clover in lawns. Control is seldom necessary, but are easily controlled with BHC, 2 pints of 11% E. per acre.

Cicadas and "Cicada-killers" - The cicada nymphs often leave holes in turf, particularly under trees when they emerge to become adults. The cicada-killer wasp digs deep burrows in the ground and mound soil up around the entrance. The holes are large enough to accommodate the bodies of paralyzed cicadas which the wasps drag into the burrows. They are not known to sting or injure humans, unless they are handled. Sprinkle the mounds or infested area heavily with chlordane dust, or granules, or lightly with 50% chlordane wettable powder and wash it in with a large amount of water.

Sowbugs and Pillbugs - Sowbugs and pillbugs are light gray to slate colored animals up to 1/2 inch long. When disturbed they roll up into tiny balls. They are usually found on damp soil under boards, leaves, etc. They feed on organic matter and occasionally on grasses and other plants. Control is seldom necessary, but they are readily controlled with materials such as chlordane and dieldrin. Use 1-1/2 lbs. of a 5% dust, or granule formulation per 1,000 sq.ft.

Ground Pearls - Ground pearls are scale insect nymphs which are covered with a hard, shiny, globular shell about 1/8 inch in diameter. They sometimes damage Bermuda grass and centipede grass in the South and Southwest. No satisfactory control is known.

References:

Mimeo E-61, "Lawn Insects and their Control", Department of Entomology, Purdue University.

The U.S.D.A. has recently published a Home and Garden Bulletin,

No. 53, entitled "Lawn insects - how to control them." It is for sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C. The price is 15¢. I think you would find this well illustrated bulletin quite helpful and well worth the small cost.

Insecticide Formulations Available

<u>Insecticide</u>	<u>Dust - %</u>	<u>Granules - %</u>	<u>Spray Forms</u>	
			<u>Wettable powders - %</u>	<u>Emulsifiable conc./gallon</u>
Aldrin	2.5	2.0	25	2 lbs.
Chlordane	5.0	5.0	40	45% - 4 "
				75% - 8 "
DDT	5.0	-	50	25% - -
Dieldrin	1.5	5.0	25	1½ "
Heptachlor	2.5	2.5	25	2 "
Lindane	1.0	-	25	20% - -
Malathion	5.0	-	25	5 "
Toxaphene	10.0	-	40	60% - 6 "

Summary Table on Insecticides

Turf insect control generally is in two categories:

A. For grubs, wireworms, ants and soil-feeding, or soil-living insects apply toxic concentrations to soil which persists often for three years.

B. For leaf chewing and sucking insects, apply light rates to leaves so it remains on the food of insects. Since new broods of larva may hatch, even weakly, re-treat as often as needed to maintain control. Always follow container directions closely.

<u>Insecticide</u>	<u>Pounds of Active Ingredient per acre</u>	
	<u>For grubs and soil feeding types</u>	<u>For cutworms and leaf-feeding</u>
Heptachlor	2	1
Chlordane	10	1 - 2
Aldrin	-	1
Dieldrin	3.5	.5
Malathion	-	.6
Toxaphene	-	.5

CHEMICALS FOR CRABGRASS CONTROL

J. E. Gallagher, Agronomist
American Chemical Paint Co., Ambler, Pennsylvania
(Presented before General Turf Section of M.R.T.C.)

The use of chemicals to help solve our turfgrass problems is now an accepted management practice. Crabgrass, with its strong growth characteristics associated with today's player demands, can hardly be kept in check without the use of chemicals. The development of new chemicals follows a fairly well established testing pattern. Today, I plan to discuss those chemicals now undergoing widespread testing.

I have collected the various reports relating to crabgrass control and have separated the chemicals into pre- and post-emergence treatments. The varied techniques used in making application and analyzing the data makes my summary somewhat like the comparison of apples and pears, but I hope to show you a consistency of results whenever it occurs.

PRE-EMERGENCE CONTROL

It seems logical to discuss first those chemicals being tested for pre-emergence crabgrass control. What I have done has been to take each report, separate the chemicals and treatments, and put them together in table form. This will give you the source of work, rate per acre, (in most instances active ingredient), number of treatments and control figure.

NEBURON

3-(3,4-dichlorophenyl)-1-methyl-1-N-butylurea: This material, which showed considerable promise in 1955 as a pre-emergence chemical, was extensively tested in 1956. It is a wettable powder 20% formulation.

<u>Contributor & Location</u>	<u>Formulation</u> <u>lb./A</u>	<u>No. of</u> <u>applic.</u>	<u>Relative</u> <u>Control</u>
Daniel, W.H., & Goetze, N.R., Lafayette, Indiana	4	1	50%
do	6	1	55%
do	8	1	70%
Hart, R.D., & Ingle, M.	4	1	37%
do	6	1	45%
Davis, R.R., Wooster, Ohio	4	1	60%
do	4	2	97%
do	8	1	90%
Hogard, T.W., Hemphill, D.D. Columbia, Missouri	4	1	40%
Stadtherr, R.J., & Nylund, R.E. St. Paul, Minnesota	4	2	85%

Musser and Duich - non-published data presented at the 1957 Pennsylvania Turfgrass Conference showed that multiple applications of 4, 6 and 8 lbs. total chemical per acre produced much better results than single applications of equal amounts of material.

The above data indicates that: first, a single application requires a minimum of 8 pounds per acre for satisfactory control; secondly, if that 8 pounds per acre is split into several applications, superior control is achieved.

ALANAP 1F

N-1-Naphthylphthalamic Acid - this material was also tested quite widely in 1956. It is a 1% formulation incorporated on vermiculite for spreader applications. It contains a soluble fertilizer and should be watered in to prevent discoloration.

<u>Contributor and Location</u>	<u>lb/A</u>	<u>No. of applic.</u>	<u>Relative Control</u>
Daniel, W.H. and Goetze, N.R., Indiana	800	1	88%
Younger, V.B. & Fuchigami, T., Los Angeles, California	800	3 (3-1 to 4-15)	1.5 plants per sq.ft.
do	800	3 (3-22 to 6-22)	22.3 plants per sq.ft.
do	Control		93.9 pl/sq. ft.
Davis, R.R., Ohio	800	2	91%
do	2400	2 (split applic. 1600-800)	99%
Hogard, T.W. & Hemphill, D.D., Missouri	800	2	100%
Stadtherr, R.D., & Nylund, R.E., Minnesota	800	2	50%

There is consistency of control with this material, but once again multiple treatments proved more effective. The California series show the importance of timing.

INORGANIC ARSENICALS

The use of lead arsenate for pre-emergence crabgrass control has been quite controversial. During the past few years, a commercial formulation of arsenicals called PAX has been tested in the West which produced good results. Its use area, or sales area, is being increased to cover a much wider range. Therefore, I have included it here:

<u>Contributor & Location</u>	<u>lb/A</u>	<u>No. of applic.</u>	<u>Relative Control</u>
Daniel, W.H. & Goetze, N.R., Indiana	Lead arsenate 1000	1	87%
do	Calcium " 600	1	91%
Younger, V.B. & Fuchigami, T., California	Lead arsenate 300		
	Milorganite 1740	1	17.13
do	Control --	-	95.4
do	PAX 1435	1	100%
do	PAX 1087	1	100%
Quinlan, L.R., Manhattan, Kans.	PAX 1087	3	95-100%

You can see that Dr. Daniel has obtained satisfactory control with both lead arsenate and calcium arsenate, while Dr. Younger has shown fair control with a combination of lead arsenate and Milorganite. PAX, a mixture of carrier, lead arsenate, arsenic oxide, chlordane and nitrogen fertilizer, which seems to offer effective control in certain areas, should be considered as a possible chemical for pre-emergence control.

POST-EMERGENCE CONTROL

Disodium Methyl Arsonate

<u>Contributor & Location</u>	<u>Formulation Rate of applic.</u>	<u>No. of applic.</u>	<u>Relative Control</u>
Daniel, W.H. & Goetze, N.R., Indiana	8 oz/1,000 sq.ft.	3	Satisfactory
Davis, R.R., Ohio	2 oz/1,000 sq.ft.	2	87%
do	2 oz/1,000 sq.ft.	3	82%
do	4 oz/1,000 sq.ft.	1	71%
Hogard, T.W. & Hemphill, D.D., Missouri	8 lb/A	3	100%

Application at 80° injured bluegrass slightly; injury to bluegrass was very severe at 95°.

			<u>Plants per sq.ft.</u>
Stadtherr, R.J. & Nylund, R.E.			
Minnesota	4 lb/A	3	28.0
do	6 lb/A	3	23.3
Control	---	-	93.8

Slight discoloration of bluegrass was reported.

Quinlan, L.R., Kansas	2.7oz/1,000	3	92
Slight discoloration of bluegrass was reported.			

Younger, V.B. & Fuchigami, California	6.7oz/1,000	1	65.4
do	6.7oz/1,000	2	11.2
do	6.7oz/1,000	3	20.9
Control	---	-	95.9

Musser and Duich: Unpublished data showed that 2, 3 and 4 treatments at 7 pounds per acre produced 95 - 99% control, combinations of PMAS followed by two treatments of disodium methyl arsonate - a total of four treatments - gave 95% control.

KOCN - POTASSIUM CYANATE

<u>Contributor & Location</u>	<u>Rate of applic.</u>	<u>No. of applic.</u>	<u>Control</u>
Hogard, T.W. & Hemphill, D.D., Missouri	10 lb/A	3	67%
Quinlan, L.R., Kansas	8 lb/A	3	40%
Stadtherr, R.J., & Nylund, R.E., Minnesota	7.3	3	4.5 (90%)
Musser, H.B., & Duich, J., University Park, Pa	8 lb/A	2,3,4	92-97%
Combination treatments of PMA followed by KOCN 3 and 4 treatments produced 96 - 98%.			

KOCN MCP

Hogard, T.W. & Hemphill, D.D., Missouri	15 3 lb/A	1	82%
Severe discoloration of bluegrass turf reported.			
Stadtherr, R.J. & Nylund, R.E., Minnesota	15 3 lb/A	3	100%
Severe discoloration of bluegrass reported.			

PMAS

Hogard, T.W. & Hamphill, D.D., Missouri	.7 lb/A	3	43%
Stadtherr, R.J. & Nylund, R.E., Minnesota	.9 lb/A	3	4.25 (85%)
Quinlan, L.R., Kansas	6 pt./A	3	93%
Musser, H.B., & Duich, J., Pennsylvania	7 pt./A	2,3,4	95-99%
Daniel, W.H., & Goetze, N.R., Indiana	6 pt./A	4	97%
Davis, R.R., Ohio	5.5 pt/A	3	95%
do	4 pt/A	-	96%

Miscellaneous Post-Emergence Chemicals

Daniel & Goetze	(cacodylic acid)	15 oz/1,000 sw.ft.	3	91%
do	(arsenoacetate)	5 do	3	45%
do	(petroleum distillate)	1 gal/ do	3	46%
Stadtherr & Nylund	(arseno acetate)	1.6 lb/A	2	0.0
do	(petroleum oil)	108 gal/A	2	100%
Complete kill of turfgrass occurred with this treatment.				
Davis, R.R., Ohio	(arsenoacetate)	1 oz/1,000sq.ft.	3	45%
Hogard & Hemphill	(sodium arsenite)	1 lb./A	2	0.0

The information presented here is the latest results obtained by several research workers throughout the country. As you study these figures, you will note that there is a certain amount of consistency associated with several of the chemicals. The importance of timing with pre-emergence chemicals and temperature with post-emergence chemicals was brought out in this discussion. In brief, it appears that we have several chemicals available to us that will control crabgrass. How successfully we control crabgrass depends on our conformance to the specific environmental requirements of each chemical.

MAINTAINING APRONS, OBSERVATIONS

C. G. Wilson, Agronomist, Milwaukee Sewerage Commission
(Presented before Golf Course Section, M.R.T.C)

Possibly a Chicago superintendent had the most logical solution towards improving collars. Turf improvement was accomplished by reducing the size of the greens.

Few could follow this procedure, yet many might wonder why it worked. The answer was simplified management. By reducing greens in size, the collar and putting grass became exactly the same. Of equal importance the soil texture and structure were alike for both greens and aprons.

These facts are worthy of consideration in any rebuilding program. Of necessity, collar maintenance must closely approach that given to the putting green proper. This is especially true in relation to the irrigation practices. Soils and grasses differ in their moisture requirements. When the soil and the grass on aprons and greens are similar, management becomes relatively simple.

The trend toward higher sand content in soil mixtures may work well on greens. If the "collars of clay" are forgotten, the grass on one or the other will suffer. A sprinkler can't distinguish the difference. If the green receives the right amount of water, the collar will be either too wet or too dry.

The best collars are maintained exactly like the greens. Disease and insect control methods are practised, weed killers are used, and fertility levels are high. In many instances, clippings are removed to reduce disease, and where play is heavy, frequent aerifying or spiking is done to relieve compaction.

In hot weather when the collar grass is shallow rooted, special care is taken to avoid mechanical damage. Wide sweeping turns with putting green mowers protect the collars as well as the greens. Some mow collars in early morning when the chance of wilt is reduced. Others syringe the grass immediately if mowing is done during mid-day. In the

Detroit area one course saved its damaged collars by switching from the fairway tractor and gang to a lighter triplex.

Sodding or plugging is the most foolproof way to improve deteriorated collars. Improved strains or better adapted species should be considered. Creeping bents are best under low cutting. Zoysias and winter hardy Bermudas are being tested in the crabgrass belt. Merion bluegrass has been tried with limited success. In several instances bentgrass or poa annua has taken over in two or three years. Bill Stupple at Exmoor has "horseshoe collars" of Merion around several greens. The open end leads to the approach. Bill feels that excess moisture there would be bad for Merion. As he waters collars by hand during the summer, chances for success are greater.

Power sod cutters should simplify the introduction of better grasses. Where lack of nursery area is a limiting factor, some favor introducing weed free Kentucky bluegrass from the rough. It is mowed to the desired height and overseeded with a mixture of creeping and Colonial bentgrasses. As the Kentucky bluegrass gradually vanishes, the bents take over. The major advantage is elimination of annual bluegrass competition. The weedy collar sod is replaced in the rough. In one or two seasons it will revert to Kentucky bluegrass as a result of high cutting, limited moisture and no compaction. Sodding may seem costly - at least initially. Often the end results justify this method.

Overseeding aprons is commonplace, yet often disappointing. If results have been poor at your club, newer techniques might prove of value. Whatever the method used, a good seedbed is imperative always. Thorough aerifying and spiking is essential. Seed must make intimate contact with the soil or results will be poor.

There is a general feeling that successful overseedings depend on seedling emergence before weeds germinate. Thus, one can get the jump on fall annual bluegrass germination by seeding in early August. At this time bent will germinate even though temperatures may be too hot for poa annua. Pre-germination may be useful to keep one step ahead of crabgrass during a cold, wet spring. Seed mixed with 2 to 3 times its volume of fine grade vermiculite is kept moist for 3 to 5 days at a constant temperature of 70° F. This initiates the germination process so seedling emergence in the field is rapid. In either instance moisture is critical. Light frequent irrigations are required until the grass is established.

Seedbed sterilization may have a place especially with some of the newer weed killers. Vapam shows considerable promise. It kills all existing vegetation and can be applied with a sprinkling can. It is necessary to wait 2 to 3 weeks after treatment before reseeding.

Surface compaction from mowers and traffic is an ever present problem while the seedlings are becoming established. Orville Young, while at Moraine Country Club, favored liberal topdressing with ground corncobs to protect the young seedlings. Andy Lentine of Tumble Brook Country Club in Connecticut kept the mowers off his hurricane damaged collars until the seed was established. His method was circular mowing on the greens. It eliminated any danger of friction bruise caused by putting green mowers turning on the collars. Both methods worked well.

MAINTAINING APRONS AROUND GREENS

O. W. Young, Middletown, O.
(Presented before Golf Course Section M.R.T.C.)

Anyone who has had the responsibility of renovating and holding good grass on aprons of greens surely know it has always been one of the golf course superintendent's big challenges. Good aprons are very important from the game standpoint. Besides, poor weedy thin and dead patched aprons are a terrible eye sore to a beautiful green and other surroundings.

Most of the faulty maintenance practices which, I think, would help to contribute to poor aprons are:

1. Height of Cut. When I give in under pressure by the demand of just a few of the members, for too close of a cut (approximately 1/2 in.) the turf, bent and poa would thin out and even die in patches, letting crabgrass and goosegrass take over.
2. Did not use the same maintenance practices, except mowing, as was used on the greens. I think the use of fungicides, insecticides, plant foods, aerification, topdressing should be practiced on the aprons as part of the greens.
3. Not enough water. Seldom does enough water penetrate into the soil usually due to the runoff from compaction, grade and faulty soil texture, or structure.
4. Aprons too small. On some of our greens the aprons areas were too small to allow enough turning room for mowers, spikers, etc. Then, fast twisting turns were made which bruised the tender grass and can kill the turf. Especially, if mowing and etc., is done during the heat of the day.
5. General renovation. Seldom did the ordinary seeding practices get the turf. Even if the seed could germinate the young tender seedlings cannot take the abuse of the wear and tear subject to aprons.

This is what I did to improve aprons:

1. Mowed three times a week, preferably when cool, through growing season, on Monday, Wednesday and Saturday at a height of approximately 3/4". On Sunday or holidays when aprons were not power mowed, I had one swath mowed next to the greens with a hand mower set at approximately 1/2" to please the bulk of the players. This practice eliminated most of the complaints on long grass on aprons, because the players could stroke a ball that was near or against the edge of the taller apron's grasses.
2. Except for a higher cut the aprons were maintained as part of the greens proper. Diseases, insects, weeds and a general unhealthy turf developed when fungicides, insecticides, fertilizer, aerification and topdressings were not used regularly.
3. The greens and aprons are watered by sprinklers very early in the morning. The aprons, with extra attention to the higher spots, are always given an extra hand watering. This tends to cushion the aprons

against injury from equipment, players carts, etc. It also keeps the edges of the greens from burning out.

4. When the aprons are entirely too small for the slow big turn of the mowers, or other equipment, then either the apron should be extended into the greens, or widened from the outside to give enough room. There is nothing so hard on tender grass as the twisting or spinning of equipment and especially the mowers on hot turf with dry, hard soil beneath.

5. When some renovation was necessary I used aerifiers or spikers to loosen up the top soil.

6. Slow down mowers on turns, even to extent of taking machines out of drive-on turns.

Instead of depending entirely on seed, the old reliable plugging, crow footing, or clump plantings of desirable established bents taken from nursery were transplanted, with care, into the thin apron turf, then over-seeded with Colonial bent and topdressed heavy with 1 part crushed corn cobs to 4 parts sandy loam compost. I think coarse vermiculite would also be a good additive instead of crushed cobs which tends to cushion and help protect the young, tender grass until established.

THE PUBLIC AND THEIR GOLF COURSES

John Vaughn, Supt. of Golf, Indianapolis, Indiana
(Presented before Golf Course Section, M.R.T.C)

The municipal golf course has become a favorite place for relaxation. Formerly it was considered a rich man's game, also dubbed by many of the younger set as a game for sissies. But time has changed this picture - it has now become one of the most common forms of outdoor recreation for moderate-income families.

This has given rise to an overflow demand on public golf courses in Indianapolis. We have industrial leagues who have regular scheduled play on weekday evenings for those who work in the day time. These leagues have a few matches on Saturday and Sunday mornings, which we work in with our regular club play without much interference.

Indianapolis is probably one of the better places for a golfer to live as we are fairly well blessed with golf courses in this city of 500,000. We have at the present time six municipal courses, two public fee courses, one U.S. Army and seven country clubs, a total of sixteen courses.

In the spring of the year we hold free golf clinics, one on each of our city courses starting at 4:00 P.M. until 5:00 P.M. for girls and

boys up to 18 years of age; from 5:00 P.M. to 6:00 P.M. for those of the 18 years and up bracket. This creates an interest not only for the beginners, but also gives those who play a refresher course in the fundamentals of the game which is easily forgotten by those of all ages.

To keep the public course player fairly happy, we try to maintain good greens and tees. We are now in the process of enlarging all 99 tees with the thought in mind of trying to have some sort of grass tee reserving the back 1/3 for U-3 Bermuda for tournament play. The fairways do not get too much attention as far as water and fertilizers are concerned because our budget will not allow it. So, we keep them as well groomed as possible and hope for the best.

On six municipal courses we had a total of 178,000 rounds of golf played in 1956, with a total revenue of \$ 133,000.00. Expenditures for all courses was \$ 150,000.00, thus an operating loss of \$ 17,000.00. This was with a daily fee of 75¢ for weekdays, and \$ 1.00 on Saturday, Sundays and holidays, and \$ 30.00 for a season ticket. We feel with the increase for 1957 we should break about even.

In 1957 our fees will be \$ 1.00 on weekdays, and \$ 1.25 on Saturday, Sunday and holidays. Season tickets good on all municipal courses are only \$ 40.00 per year. A Junior ticket is \$ 15.00 for children up to 18 years of age. No child under 10 years of age is allowed on the golf course.

LEAGUE GOLF AND MY COURSE

Harold W. Glissman, Manager and Operator
Indian Hills Golf Course, Omaha, Nebraska
(Presented before Public Golf Group of M.R.T.C.)

League play at my course has been something that I have promoted to the maximum. We have had organized play on our courses for over 15 years.

The first golf league we had was the work of our local Y.M.C.A. They started with eight teams of 5 to 7 men per team. Four men played on each team for a period of two rounds each for two periods 14 weeks. There was a final play-off between the winners of each round for the championship of the league. This type of play is still used today, only that we insist on 3 rounds (total of 21 weeks). The winners of each league play for the City-wide Championship of the Y.M.C.A. Golf Leagues. There were 6 leagues of 8 or more teams in 1956 and they are organized to play again in 1957. There are four leagues at my course, and the other two at one of the municipal courses.

The Y.M.C.A. Leagues have 2 evenings each week, with 2 leagues of 8 teams playing each night. I schedule a league on each nine after 5 P.M.; they play 3 rounds (21 weeks) plus field days and their play-off round. This gives me league play from about April 15 to September 15.

In the last 5 years my league play has grown from 32 teams per week to over 100 teams, which means we have leagues every weekday evening Monday through Friday; a Monday morning league; a Ladies Wednesday league from 6 A.M. until 11 A.M., and a league on Sunday at 10 A.M.

Now, a little about how we operate and what we do for the leagues. Every league we have plays on a 6 point system. One point for each match and two points for low team total. Points are split in case of ties.

All of our leagues, except one, play on a handicap basis of about 70% of the difference between player's handicaps. Handicaps are figured each week by a secretary. The secretary should be picked with care as his job is not only to figure the handicaps each week, but to furnish pairings, standings, settle disputes and report to the local newspaper the results and happenings to his league. In other words, he does most of the work. Individual and team trophies are a must. If possible, a traveling trophy, to be won three times for permanent possession, is also desirable.

We have one scratch league with no handicap. This league can mean your biggest source of publicity for your course, because your local newspaper is always interested in the best players and what they are shooting.

Our Classic League, as we call it, is a sponsored league, which means that everything is paid for by some individual or company. This includes golf fees, team shirts, some of the weekly prizes, secretary's fees, etc. Each player pays a \$10.00 membership fee, which is used for prize money and an insurance to the sponsor that he will have a full team all season. This league is now 4 years old and getting stronger every year.

The most important part of this league is to be sure the teams are as evenly matched as possible as to playing ability. You cannot have a successful league by having the 5 best players on one team. What I did was to take the eight best players and make them captains, then they picked 2 additional players. A team committee then added 2 or 3 additional players to make up the team. By controlling the players on every team no team has won the championship twice in four years of play. The sponsor fee for this league is \$ 150.00 per team.

Shirts are an important part of this league; in fact, any league. As you all know, we here in the good old U.S.A. are a little uniform conscious, and you will find that your players, when playing away from home in a weekend tournament will wear their shirts, if they are outstanding and colorful. This is advertising for a sponsor.

We have a Blind Bogey for each league every nite and give a top grade golf ball as a prize; also a prize for low net score. We give the league committees a liberal discount on merchandise prizes for field days and special events. This, I feel, is important. You can say "thank you" for their patronage in a way that does not cost you any money and still makes your league players happy. League play will help your regular play because they will play your course whenever possible to become more familiar with it, and have a better chance to win next week's match.

Our source of leagues has come from all types of business. Some companies that have a league or leagues, pay all or part of the golf fees. However, this is the exception rather than the rule. We have

only one company that pays everything. They feel it is one of the best labor relation investments they have ever made. This type of league is one of the best because you don't worry about whether or not you will have a full league every night. Guranteed payment, by individual leagues, is difficult to obtain for entire seasons. However, we have built our league business up to a point where we have requests for more league time than we are able to give. Therefore, we can now demand full payment from each league every night for the entire season. This, I assure you, is a nice position to be in. If you give and take a little along this line, I am sure it will pay off in the end. Most every player realizes that you have given them a place and time to play and are there every week. Company leagues are no problem. It is the public leagues, which have from 6 to 8 different sponsors, that make it difficult to collect for an entire season.

We have talked about evening leagues, but don't overlook the other possibilities. Morning leagues for the night worker, the ladies leagues that can be organized among the ladies husbands who can't belong to a country club. To me they are good business. Last year we had 145 ladies signed up to play on Wednesday mornings. They started to play anytime between daylight and 11:A.M. This year their group has expanded to the extent that they want two mornings each week. My play is not so heavy in the mornings that I don't welcome 75 to 90 players guaranteed for 20 to 25 weeks during the season. Your conditions may not permit this if you are at a municipal or city owned course, but for the privately owned and managed course, I am sure you can increase your gross for the year with this type of play. Personally, I don't care where the gross comes from just so it is there at the end of the season.

I also have a 12 team league that plays on Sunday. We always had a slow period from about 10 A.M. until 12:00 noon, when we have a fee price change. I was fortunate enough to get this league of 48 players and usually 2 to 6 extra men to play. To me this is good business to improve the so-called gross.

League play at your course will not come over night. It takes a lot of work and publicity year after year. Your local newspaper will play a big part in the success of your leagues. Give them news about matches, results, low scores, etc., and give it to them regularly -- they will give you the space. Golfers are no different than any other person - they like to see their name in print for doing something, or winning a prize. Be sure and try to have a sports writer in attendance at all meetings and events, if possible.

Golf leagues are a big factor in any of my future plans. Because I feel they are a must to the successful operation of a daily fee course, that is to be operated for a profit.

Rules of Omaha YMCA City-Wide Golf Leagues - 1957 Season

Type of Play

Sec. 1: The leagues will be between two four-man teams playing one match weekly as per schedules.

- Sec. 2: There are a total of 6 points in each match. Four points are to be decided by individual match play on a handicap basis. If any individual matches shall result in a tie, each player will receive 1/2 point. Two points will be awarded to the team having low score.
- Sec. 3: Low handicap man of each team is the No. 1 player, second low man is No. 2 player, etc. This numbering applies to players present for any match.
- Sec. 4: The No. 1 man of one team shall compete against the No. 1 man of the opposing team in all matches and the same rule prevails for all other players.

Method of Play

- Sec. 1: All play will be handicap match play and 9 holes will constitute a match. U.S.G.A. and ground rules, as shown on the score cards of the courses played, will govern all matches except the out of bounds rule which is: "For an out of bounds ball the penalty is the loss of distance and one stroke. If ball is out of bounds a second ball must be played. If in doubt a provisional ball should be played."
- Sec. 2: All score cards will be turned in at the end of the match to the League Secretary. Each score card will be signed by the captain of each team. Totals will be added and winner of each hole designated by encircling the score of that hole. Use last names of players on score cards and show date played.

League Rules

- Sec. 1: Entry Fee - \$ 1.00 per team per week payable one week before League Play starts. YMCA Membership Dues - \$ 1.00 per man per year. Payable before man is eligible to participate in the YMCA Golf League. A player must pay \$ 1.00 per league of which he is a member. More than one league registration the money goes to the League Treasury.
Example - If a player is registered in both the Sam Snead and the Walter Hogan Leagues he must pay \$ 1.00 per League, or a total of \$ 2.00.
- Sec. 2: Missing Players - Each team must have at least three Bona-fide registered players present to compete in a match. A team may borrow only one player per match.
Example - A's team has only two players. A may borrow one registered player and play a match with three men. If A's team has three players, he may borrow one registered player and play a match with four men. You cannot borrow 2 men.
A team playing a three man match forfeits the fourth match point and must use opponents highest single net score in determining low team net score.
- Sec. 3: Forfeits - Teams not showing up as scheduled (provided no previous arrangements have been made by 1:00 PM the day of the match) shall forfeit the match. (Total 6 points) 5:45 is the deadline for teams to appear. Any team forfeiting twice in a round automatically forfeits 6 points to all teams in the League for that round. No League round winner shall be decided by receiving a forfeit during a round. The two teams involved must participate in a match using current handicaps within one week after the end of the round.

- Sec. 4: Time of play - Play may begin at 4:00 PM. However, the captain of a team that cannot be present then may arrange with the captain of the opposing team (but not later than 1:00 PM the day of the match). It is recommended that team captains contact each other well in advance of weekly matches and arrange to play as early as possible.
- Sec. 5: Postponements - Regular weekly matches or matches scheduled on holidays, or in case of matches being called off due to rain at or during time of playing, captains of opposing teams shall arrange to match cards following week.
- Sec. 6: Protests - Any protests as to score or otherwise shall be settled by players concerned before score card is turned in at the end of the match for final recording. If differences cannot be settled, they must be taken up through the League Secretary whose decision is final. Protest must be filed before leaving the course the day of the match of the protest game.
- Sec. 7: Play-Offs for League Champions to be conducted on four match points and two low net points except in instances where more than two teams are in competition. In these instances play-offs shall be conducted on a low net basis entirely. All around winner play-offs must be completed within the two weeks following League completion.

CHAMPIONSHIP PLAY-OFFS

- Sec. 1: To be eligible for play-offs, a player must have participated in 50% of the regular scheduled matches in his league.
- Sec. 2: The winning team of each round in each league shall be eligible to participate in the play-offs.
- Sec. 3: The winning team in the play-offs will be that team with the lowest net score and will be called "THE CHAMPIONS OF THE YMCA GOLF LEAGUES".

TURF ORGANIZATIONS AND THEIR PROGRAMS

W. H. Daniel, Dept. of Agronomy, Purdue University
(Presented before M.R.T.C.)

Those of you attending this Midwest Regional Turf Conference realize it is sponsored by the Midwest Regional Turf Foundation located at Purdue University. Many of you have encouraged your organizations and companies to maintain membership in this Foundation as a means of promoting Turf Research and such educational activities as this.

It should be of interest to you to see a little of the larger picture of turf promotion and utilization which is coming about so rapidly in the

United States. Therefore, I would like to review some of the organizations and give a little of their program.

U.S.G.A. Green Section

One of the most noteworthy and serviceable organizations over the years has been the Green Section of the United States Golf Association. Certainly some of you recall the early work of Piper and Oakley, then Monteith and Welton; then, of course, the outstanding work of Fred Grau while director. Today the U.S.G.A. has developed their Green Section service for member clubs to the point that they have seven agronomists. These will serve all regions of the United States with their latest addition in personnel serving our Midwest area. I would particularly like to compliment the Green Section personnel on their very hard work and enthusiastic effort towards the accomplishment of real service to the U.S.G.A. members.

In the total turfgrass picture of the Green Section is currently providing considerable funds for research which have been pulled together from Green Section subscriptions by industry, from National Golf funds and days, and from Green service subscription clubs. We, at Purdue, have a \$ 2,000.00 grant which is being utilized from them. The main job of the Green Section today is to promote research - not conduct it personally, and to carry a well planned program of consumer education and counseling to those serviced.

Increased Experiment Station Activity

The major reason for this talk is to point out to you here in the Midwest the formation of a new North Central Research Committee. In this, each Experiment Station Director has appointed someone in each of the 12 states to attend committee meetings and to participate in the organization of a strong turfgrass research program concerned with the regional needs for our area, and at the same time there has been formed a Northeastern Turf Research Committee for the same purpose in that area. This is a very progressive step since it allows for the states, at present not having an active research program, to have the benefit of the interchange of information and the accumulation of material which can be helpful to them. Also, it offers the possibility of channeling U.S.D.A. funds into research on a regional problem.

The North Central Committee first met in Chicago last fall and met here at Purdue last week. Plans are well advanced and I am very optimistic about the possibility of such regional activities when divided among the states with adequate interchange of information.

A.S.T.A. Considers Turfgrass Division

For several years the interest in grass seed utilization and improvement has expanded in the American Seed Trade Association. Under the strong leadership of Mr. Bob Huey and the following leadership of Mr. C. B. Mills, a committee has acted and recommended the A.S.T.A. form a turfgrass division. It can be a focal point for the bringing together of information for those within that industry concerned with turfgrass seed distribution and utilization. Such a forward step provides real opportunity for new grass varieties to be studied, tested adequately and adopted judiciously.

Agronomists for Industry

Perhaps the agronomist employed by industry, to better service the clientele and users of industrial products, is the biggest change you have noticed in turfgrass. Today many people with excellent training are participating in this Conference, and others throughout the country are participating in your local meetings and visiting with you at your respective turf areas to learn, exchange information, and provide to you services and materials for better turf. They are real friends of yours. Today industry can find funds to build plants and certainly can make a wide variety of compounds which can accomplish specific things; for example, slow release of nitrogen, or selectively killing weeds. However, they also want you to use the material correctly and wisely so that satisfaction is secured. Such educational efforts by industry will materially increase.

Better Lawn and Turf Institute

This organization has been in operation for several years, but under the strong leadership of Dr. Robert Schery is now in a position to have considerably more publicity and interchange of information than previously. As I understand it, this organization's chief purpose is to provide information on current utilization to a wide range of consumers, particularly homeowners.

Basically they share the same goal as does The Turf Research Foundation with headquarters in New York who also are concerned with better grass utilization, but are also spending funds to encourage research on new varieties. Mr. Arden Jacklin of Dishman, Washington, who is appearing on this program, is the President of that organization. Both Better Lawn and Turf Institute and Turf Research Foundation can be of real assistance in the wide dissemination of information.

There are many organizations in which producers have combined, for example, The Merion Bluegrass Association, The Red Fescue Commission of Oregon, The Emerald Zoysia Growers of the South, etc. All of these have, through their joint efforts, provided for the exchange of information and the promotion for better utilization of their materials.

Where does this place you, the supervisor of turf areas? Certainly you can count on having more educational opportunity such as the wide range of people participating in this Conference. You can count on having the resources of more publications. And, you can count on the necessity to you to understand the variation in chemicals, fertilizers and grasses so that your turf will always be ready for use. The turfgrass field today is one of the brightest in all of agriculture as a means of gainful employment and a means of using technical information.

SEED FIELD PROBLEMS

Arden Jacklin, Mrg., Jacklin Seed Co., Dishman, Wash.
(Presented before the General Turf Section of M.R.T.C.)

A critical examination of the turf seed production industry would, I am sure, establish the fact that marketing is the constant and ever most

pressing problem. Contrasted to the constant pressure of marketing are seed field problems, but in quite a different way. Seed field problems are questions of degrees or intensities and are in constant change or flux as techniques are developed to counteract or combat them.

In specialized production of grass seeds, accumulated knowledge is increasing, yet we know woefully little about plants, soils and seed setting. We know, for example, that Kentucky bluegrass has a seed production potential of up around 2,000 lbs. per acre. Amazing? It certainly is -- but -- we have already grown over 1,500 of net clean 98% purity seed per acre from a 20 acre field of one variety, and have topped 1,200 lbs. per acre of Merion. But, there were the exceptions and we attempt to duplicate those performances, but we so seldom succeed. We are now up in the 200 pound range, but we have too many fields still producing only 100 pounds per acre. Similarly, in creeping red fescue we have grown over 1,500 pounds per acre on a field in one year, but a 600 to 800 pound average is quite respectable.

The foregoing discussion clearly shows the challenge facing producers. It is a great game -- never static -- always changing -- and with a long way to go. You would likely be interested in phases of our seed field problems -- what they are, what we are doing about ~~them~~, and what we have yet to do. Possibly you may get an idea or two which you might adapt to your operation. Let's lead off with:

SELECTION OF KIND AND VARIETY

In our experience in the total field of forage and turfgrasses, 7 out of every 10 "new and improved" ones fail to make the grade. So, because it's "new" means too many times to seedmen that it hasn't even a 50-50 chance. A problem seemingly without solution except individual gamble and sagacity. But, at the same time, how sweet the reward in case of marketing, demand and financial returns from picking a winner as for example, Merion bluegrass.

Production and use trends vary too. It wasn't too long ago when Alta fescue was in serious undersupply. Prices were high -- in fact, supported at some \$ 30.00 per cwt. by government and did we ever grow it! At the close of the last year of price supports, the government alone owned enough Alta for 10 years of normal usage. That was 5 years ago and Alta now brings the grower less than 10¢ per pound. We grew Ladino clover too in the hey-day of \$ 1.00 to \$ 1.25 per pound seed. Last week it was near 30¢.

We're catching up on Merion needs too. The 1956 crop will average out at less than double common Kentucky blue price and right now we're looking very closely because we can grow twice as much of some of the commons, as Merion, and with less work too.

I should also mention that selection of kind or variety is a much greater problem for a new grower because of specialized equipment necessary to do the best job. As, for example, the rapid-sodding and light weight fuzzy seeded Kentucky bluegrass is much more difficult to equip for than the slower sodding, smooth seeded, fine-leaved fescues.

SEED STOCKS

Foundation seed stocks of the variety wanted are not always and con-

tinually available. Sources must be continually checked for availability, even though price is minor part. Stability of the plant breeder and his station or company are of importance, as once planted and planned for market, a perennial grass is with a grower for several years.

Growers who have their very intricate and specialized drilling equipment set to do a real job on uniform seed, can get fouled up with poorly cleaned foundation seed. Even more serious is the problem of other crop and other grass mixtures. I can cite instances in our operations where upwards of \$ 50.00 per acre have been spent in roguing fields planted with foundation seed to get our undesirables which were planted with the seed.

FIELD HISTORY

It would seem self-evident that a field must have a previous crop sequence that would give freedom from possible polluting volunteer of the same or different species or variety. Past cropping history and management also determine to a great extent the kind and amount of weeds to be expected. So, the grower must nearly always temporize and go as far as he dares and yet avoid trouble with his production. Sometimes these decisions are hard to make.

STAND ESTABLISHMENT

Of all things a grower has to do, this is the most difficult. The weather may knock him out due either to chance or mistiming. Too often the soil itself, by having deteriorated tilth with crusting, provides just plain poor seedling habitat.

With extremely shallow planting necessary with very small seeds, who can guarantee that a hard dry wind won't hit just as the seed is germinating? If the seed is buried to moisture - can it make it under cool, wet conditions? It's a percentage deal, and even the best of growers may fail at times. In general, the better the grower, the less seed he plants. For example, the better growers in our area plant seed at about the following pound per acre for 30" row production: Red fescue 3/4 lb.; Merion blue 1/2 lb. And, one grower planted 10 acres with only 5 ounces of seed. Contrast these rates to a turf planting at 3 lbs./1,000 sq.ft., or 130 lbs./A.

INSECTS

Our production area does have some destructive insects. The sod webworm and cutworm are worst. Others are the timothy mite, the silvertop carrying mite, mealy bugs, wire worms and a group of plant bugs, leaf hoppers, thrips, etc.

Parathion sprays at infestation time for mites and mealy bugs are only partially effective and are expensive. Sulphur dusting is also fairly effective. Infestations are seasonal and not constant each year. Wire worm damage has been on germinating seedlings. Seed treatment with 25% lindane dust does a good job.

The sod webworm and cutworm problem is a rugged one. In August and September these worms first appear from the current year's egg hatch and if allowed to go unchecked the chances are better than 50-50 that they will wreck the field right then for the next year's production. If their population isn't quite high enough right then, they can complete the job the next

spring. I have seen fields of Pennlawn Red fescue completely chewed up and killed within four weeks after the first few little worms were observed as they hatched from eggs.

Several materials are fairly effective, including lindane, D.D.T., and Heptachlor. At the present time we are using a mixture of 1/3 lindane and 2/3 D.D.T., either as a spray, or as pellets in both fall and spring. Heptachlor is used primarily as a spring insecticide as in our experience its residual is shorter, but it is a little faster acting.

DISEASES

We just don't have much. We may have some powdery mildew in the spring -- quite easily checked with sulphur dust (which incidentally helps control mites) -- but other than that our grasses are pretty clean. No rust, no leafspot, none of the mowed turf diseases, no ergot to speak of -- let's hope we can stay this way.

WEED CONTROL

A good grower knows how to handle those he has. Today's wide array of selective weed killers provides a quite good supply of weapons. On annual weeds on seedling fields we use selectives, both pre-emergence and post-emergence -- with 2,4-D in reserve to use after the seedlings are well established.

Hand roguing and hoeing are resorted to a great deal more than you might guess. Most of our growers are skitterish about using 2,4-D if we don't have to. We know that it hurts root systems and reduces seed set and yield.

CULTIVATING

The majority of our grasses are grown in cultivated row crop system. The problems in cultivation are largely mechanical, but two other phases do exist: first, labor cost, and second, root damage when improperly performed, or mis-timed. After the year of establishment, weeds are not the primary cause for cultivation -- it's volunteer and sodding. So, cultivation is aimed at pruning back sod-formers to hold them in rows and to destroying volunteer competition with the mother plants.

On some of our cleanest soils we are considering another theory of production, namely, 12 to 14 inch spaced rows with no cultivation. In those cases the labor saving from deleting cultivation may offset the one or two years shorter and lower seed production we expect from solid seeded fields as compared to row crop cultivated fields.

IRRIGATION

Our present usage consists of normally 4 two-inch applications of water in the spring with the first irrigation rather early and successive ones at 8 to 12 day intervals. Then, we water twice in the fall to get re-growth and cover before winter. This we do -- but we know very little about what might be done differently and better. We'd like answers to such questions as:

How early to start?
How much in one application?

What intervals between?
How does irrigation affect pollination?
How much, if any, plant dormancy between harvest and starting new growth again will produce the most seed in the next crop?
Plus other questions about the effect on soil microbiology; fertility, uptake of elements into the plants; soil temperature; and effects on seed production.

HARVESTING

In our area we say, "If we can't combine it, we aren't interested in growing it." So, we directly combine all our grass seeds. Some seed fields are primarily swathed and then either stationary, or pick-up combined. A combine when equipped to direct combine grass costs over \$ 10,000.00. Then, the machine isn't any better than the operator who runs it.

It's quite a process for a machine to do the job that a combine does for bluegrass. Here is a seed light in weight, small and all covered with fuzz to thresh from still green stems of grass and then to separate out of all the green leaves and stems from a dense vegetative growth. Naturally, special attention to sieves, elevators, augers and even cutter bars is required.

Grass seeds will shatter when fully ripe and dry. The trick is to catch the seed when fully matured, but before a wind shatters it on the ground. At the safe point it is still high in moisture and must be dried. Later -- moisture is lower and most of the seed will be combined at under the keeping percentage of 13. On the low shatter hazard grasses, such as creeping red fescue, the combining start is governed by moisture testing. No field is cut till seed moisture is below 13#.

I would say that harvesting is a problem from beginning to end -- from financing to timing -- from competency of labor to exactness of moisture percentage; and if the seed shatters it is irretrievably lost. We have worked on, built and rebuilt a suction type machine to salvage shattered seed from the ground, but today it is still in trial stage only. But, in spite of the shatter danger, we believe that the gamble taken in waiting to direct combine is worth it when compared to the labor costs of binding, shocking, hauling and stationary threshing. Seed shatter from direct combine operations has been proven to be less than seed loss from swathing by Oregon State College in their test work.

CERTIFICATION

Although not a direct seed field problem, seed certification is involved in every operation of the seed production and marketing fields. Seed stocks must be handled in prescribed manner, applications and proofs filed, field history checked out, isolation verified, weed and other crop inspection made in the field, tags and seals affixed to move it from field to plant, mills inspected and approved, combines cleaned and recleaned, purity and germination tests made, standards to be met, fees to be paid, and throughout it all cooperation maintained between grower, farmer, processor, mill man, warehouseman, buyer and the certifying agency. All of our fields are eligible to produce certified seed, and all steps are followed up to final tagging and sealing.

FERTILIZERS AND SOIL CONDITION

In this subject are the most unsolved problems of all for the seed grower. Most other problems have a beginning and at least an approach to an end. But soil is a living, ever-changing thing — what is thought to be known about a field and its soil today is changed or different tomorrow.

Some theories or precepts which our Company uses in its operations:

1. Maximum seed production is dependent upon a balance between all primary, secondary and minor elements in a plant feeding program of fertilizing the soil.
2. Minor elements are of more importance in sustained seed yield than generally recognized.
3. Very seldom, if ever, is it not necessary to use a complete plant food for maximum production.
4. Ammonia nitrogen is a powerful deflocculating agent in its effect. Anhydrous injections are worst, but dry ammonia compounds do have an ultimate effect.
5. Ammonia nitrogen can continue to be used in dry compounds as a nitrogen source on seed fields if care is taken to counteract its effect in the soil by sufficient addition of calcium.
6. Growers tend to make excessive nitrogen applications that are beyond the direct needs of the grass because in speeding up activity of soil microbiology other than N soil elements are kicked out or milked out and temporarily sustain growth. Eventually, however, the process runs down in terms of optimum production.

Based on these premises we formulate our complete fertilizers on experience and growth observations and growing trials. All basic fertilizer is applied in the fall with leaf feeding urea sprays as needed to supply N the following spring.

Calcium cyanamid is applied to stubble fields before plowing and planting grass and is applied on all grass sods that are to be broken for the purpose of adding calcium for soil conditioning and clay granulation, nitrogen for decay and particularly cyanamid nitrogen for its effect on soil biology and crude organic material.

At the beginning I called attention to the present inefficiency in production with known potentials of doubling and tripling yields. We haven't arrived there and admit that in our lack of knowledge in fertilizers, soils and plants lies our biggest problem.

IMPROVED SEED FOR YOU

Arden Jacklin
(PPresented before M.R.T.C.)

The improvement of turfgrasses begins with you who are the users. It begins with you because you are the ones, who, in your use areas, recognize the turf problems and therefore define the base from which improvements can be made. Because of differences in growing conditions, no other area will experience or be able to recognize problems here as well as you.

It would not be logical for us as growers in the Inland Empire of the Pacific Northwest to outline your turf problems and then attempt under our vastly different growing conditions, to breed or select a strain to solve problems in this area.

We, as growers of seed, are vitally interested in turf work in this area so that we can grow for you those better strains or varieties that you have use for. Fortunately you have facilities here to do improvement work and we in the Pacific Northwest have the natural production environment to take the results of your work in terms of seed and make increases of them for you. Again, most fortunately, in our production area we are not beset with the wide range of diseases which you have and can make most wonderfully quick increases of high quality disease free seed for you.

It hardly needs saying that ours is not entirely an unselfish interest -- we know that you will pay more for high quality seed of improved varieties. True our costs of production are also higher because of attention to such factors as previous land history to avoid volunteer grasses, isolation of fields to prevent crossing, care in machine cleanups to prevent mixing, certification charges to insure the "pedigree" and increased costs of marketing to cover information promotion, smaller unit sales and more limited markets. Nevertheless, it has paid us to specialize in high quality improved varieties. That's why, in the last few years, you have experienced increasing interest in your area from producers.

At the same time we have had an expanded interest in our production field by breeders and users alike visiting us. This is bound to continue and grow -- we in Washington are so firmly convinced of this that we are well on the way towards creating a position in our experiment station for a specially trained man to travel, study and keep informed of using area's problems, research and new needs in seeds to the end that we can keep our production in closer tune and more currently abreast with your needs.

Hand in hand with the breeding program in the using areas goes testing and screening of selections, strains, varieties and all manner of new introductions. You are naturally receptive to new things with the idea of improvement, but at the same time we must all recognize that what may be outstandingly superior in another area, may be a dismal failure in your area. No grass can be universally superior all over, and with the "Improvement" pots boiling in many areas, releases will increase. "Improved" grasses from other areas - are and will continue to be available to you. At this point your testing program so ably carried on here at Purdue by Bill Daniel comes into play to evaluate them for you.

There are many and varied approaches of breeding, selection and others. It must be recognized, however, that the breeder must recognize not only the problem, but must evaluate its geographical size in relationship to its intensity. This then leads directly to regional approaches in research to secure those improved grasses that have the widest adaptations. With this approach production can gear itself to the larger market and reduce its costs and sale prices proportionately. In production, the smaller fields and the greater the number of varieties, the higher the costs.

Of course, there are exceptions to tying down breeding for a particular trait to the affected area. Facilities for doing the job enter here. For example, changing a variety to incorporate a pre-determined disease resistance might best be done at an institution which has personnel and facilities for doing the particular job.

The subject of improved seed has two phases: first, the improvements within the plant itself to produce superior strains or varieties. We have touched upon this. Secondly, is the physical and purity characteristics of the seed itself. I have a set of slides taken in the Spokane, Washington area to show actual seed production.

The slides, in summary, show that the western area can grow a wide range of kinds and varieties. Production for the turf users include:

- | | |
|-----------------------|--|
| Red fescues | - Creeping red fescue, Olds, Rainier, Pennlawn, Chewings, Hard |
| Tall fescues | - Alta, Kentucky 31, Goars |
| Kentucky bluegrass | - Merion, Delta, Arboretum, Geary, Carnegie hybrid, Newport |
| Bentgrasses | - Astoria, Pennncross, Seaside |
| Canada bluegrass | |
| <u>Poa bulbosa</u> | |
| Fairway Crested Wheat | |

The complete story told by the pictures illustrates a high degree of specialization on a large acreage basis for grass seed production only. The technical aspects of fertilizers, cultivation and watering are all intensively studied and used for maximum production. Special machinery for particular jobs is used. The resulting crops as shown in the pictures of the growing grass are of highest quality, weed and disease free seed. Let us know what you cant, it can be produced.

DISEASE CONTROL FOR LAWNS AND FINE TURF

M. C. Shurtleff, Extension Plant Pathologist
Iowa State College, Ames
(Presented before Midwest Regional Turf Conference)

The accepted standards for fine lawns and turf have steadily risen in recent year. This has resulted largely from continued research in turf culture (maintenance and practices, grass mixtures, introductions of new grass strains, weed and insect control, etc.) as well as disease control refinements.

Principal Constituents of a Plant Disease

Disease organism + Host plant + Proper environment

No disease epidemic will develop if any one of the above ingredients is lacking.

The Disease Organism

There are four general groups of causal agencies of plant (animal or human) diseases: fungi, bacteria, nematodes and viruses. Following are some pertinent characteristics of each of these disease-producing agencies; important in determining how they might be controlled.

Fungi - Generally microscopic, filamentous organisms that usually reproduce by spores (seeds) which are commonly airborne. Fungi lack chlorophyll, the green coloring matter in higher plants, and are hence unable to make their own food. Fungi, like animals and man, are dependent on green plants (in a living or dead state) for their food. Fungi which live on dead plants or animals are known as parasites. Most lawn and turf disease-causing fungi are "in-between", (called facultative saprophytes). These turf fungi can exist on dead plant material for long periods. When conditions (right temperature, moisture, etc.) are favorable, however, they attack living grass plants and cause disease.

The spores of fungi produce germ tubes that may penetrate directly, or through natural openings, or through wounds, into the plant causing infection.

All important lawn and turf diseases are caused by fungi. These organisms are ever-present in most turf areas. With the thousands of different kinds of fungi found in the soil, or attacking grass plants - many of which produce similar symptoms - exact diagnosis is needed. Research is constantly recognizing new fungi associated with diseased turf. Often a complex, or several fungi are found attacking even a single grass plant.

Nematodes - Eel-shaped, generally microscopic, organisms that inhabit the soil in tremendous numbers. They require water for motility. Most nematode problems are caused by their feeding in or on the roots, but some can infect the upper part of the plant. They reproduce by eggs, or living young. Nematodes are not commonly transported by wind as are the spores of fungi.

Numerous parasitic species of lance, spiral, ring, sting, stylet, stubby-root, stunt, meadow and cyst-forming types have recently been shown to be parasitic on grass roots.

Plant parasitic nematodes can only be identified by taking suspected turf plugs and subjecting them to a rather complicated laboratory soil examination by a qualified nematology laboratory.

- Bacteria - Microscopic, one-celled organisms, which cannot stand drying. None of the plant disease-causing bacteria produce spores, thus they cannot remain alive while being carried great distances in the air as can fungi. They enter plants by being carried in through natural openings, or into wounds. No serious bacterial disease are known to attack lawn and fine turfgrasses.
- Viruses - Submicroscopic bodies which must be transported from plant to plant by man's activities, or by specific insects or mites. Viruses cannot penetrate directly, but must be placed into a wound or injected during insect feeding. So far as is known, viruses cannot multiply outside their host plants or insect vectors and in most cases become non-infectious when the host plant dies. This is not true of nematodes, bacteria or fungi. No serious virus diseases are known of lawn and turfgrasses.

In addition there are physiological diseases caused by unfavorable growing conditions; water-logging and compaction, chemical injury through high concentrations of soluble salts, scorching (fertilizer burn, weed killer or fungicide injury), lack of one or more essential elements, unbalanced feeding, air pollution, etc., which may be observed as plant damage.

The Grass Plant

All plants are prey to diseases. Of the many thousands of disease-producing organisms, only a very small number (slightly more than 100) is capable of attacking any particular grass species because of the physical and physiological differences existing among plants. Even within a species there may be adequate variation so that some individuals (or strains) are highly susceptible to a given disease and others resistant. In order for a disease to become epidemic, there must be an adequate number of susceptible plants present for the disease organism to build up in quantity.

The Environment

Disease organisms are living entities and therefore respond to favorable moisture, temperature and nutrition as do other living plants. Cool, moist conditions may be absolutely necessary for the development of a certain disease, whereas, hot, dry weather would completely arrest its development; but likewise, another disease may thrive during hot, dry weather. Each fungus parasite is favored by a rather specific combination of temperature, humidity and host plant, making their identification and control somewhat easier.

Control

The development of control measures is dependent upon having a thorough knowledge of the basic ingredients of a particular disease. It is important to know where the organism overwinters, how infections take place and proceed, what protection the plant has against infection and how the organism is distributed from plant to plant.

In the following paragraphs is given a compilation of the major diseases of lawn and fine turfgrasses in the Central United States, their characteristics, symptoms of injury, and control measures. Many of these may never become abundant enough in any one area to warrant special control measures.

Generally speaking, vigorously growing grass, produced with locally recommended management practices, is less likely to become seriously injured by disease attacks than poorly cared-for turf. Before disease control measures are contemplated, recommended cultural practices should be fully carried out to aid in turf recovery.

Golf superintendents and other turf growers are faced with two major problems in disease control: (1) the need to accurately identify the disease organism before selecting and applying the proper fungicide; (2) more than one fungus may attack at the same time. In such cases a chemical specific for only one disease won't do the job. The new broad-spectrum fungicides, (e.g. Kromad and Acti-dione RZ) will largely eliminate these problems, being effective for a number of major turf diseases.

Applying Turf Fungicides

1. Spraying - This is the preferred method. High volume sprayers may be used to deliver as low as $2\frac{1}{2}$ gallons per 1,000 sq.ft. (108 gals. per acre), or as high as 10 gals. per 1,000 sq.ft. (430 gal. an acre). The higher rate is usually used in hot weather to reduce injury from mercury-containing fungicides and other chemicals apt to cause burning. Application with a boom is preferred to a single spray gun for covering large areas. Pressures of 100 p.s.i., or more are desirable to insure wetting of the grass blades.

2. Dusting - Use power or hand dusters and dusts containing low percentages of the active ingredient. Before dusting it is generally preferred to give the turf a light to moderate watering. Dusting has not been widely used for disease control on lawns or fine turf. Sometimes chemicals are applied in fertilizer.

Diseases

1. Leaf Spot, Foot Rot, "Going-out". This serious disease of bluegrasses (Kentucky, Delta, Canada), fescues, ryegrass, etc. develops from late winter to early spring and again in the late fall during cool, wet weather. Leaf symptoms include the appearance of purplish-brown, or brownish dots which later enlarge up to $\frac{1}{2}$ inch long, with light-colored centers and dark reddish-purple margins. Leaf blades may be girdled, the tips of such leaves shrivel, turn yellow and finally brown. Crowns, stems, rhizomes and roots turn brown and rot. Grass stands appear noticeably thinned and weak, or large areas are killed by May and June. Such weakened stands are quickly invaded by weeds, especially crabgrass. Small round spots, $\frac{1}{2}$ to 2 inches in

diameter are completely killed out in winter ryegrass greens.

Control: Three or four applications of phenyl mercury at two-week intervals, starting just before new growth starts in late winter should be sufficient on bluegrasses and fescuss. Use 1.5 oz. of the 10 percent active phenyl mercury, or equivalent, in 5 gallons of water, sprayed evenly over 1,000 sq.ft. Repeat the treatments in the late fall if period is cold and wet. Acti-dione has also given good control of this disease in some tests, as has Kromad.

Merion bluegrass is highly tolerant to this disease, and commonly only a purple spotting of the leaves occurs. The destructive foot rot stage does not occur on Merion. Caution: Do not apply phenyl mercury materials to Merion which is easily injured by these fungicides.

2. Curvulaia, "Fading-out" - Follows grass injury during hot, dry weather from May to October. Diseased grass has an irregular, wavy, yellowish-green to reddish-brown dappled pattern on golf greens. In lawns, 3 to 18 inch spots spread outward through the summer. The grass in the center is usually thinned or killed. Curvularia may closely resemble at times: chemical injury, drouth, a soil deficiency (e.g. chlorosis), or dollarspot. Affected grass appears to be drying out, and the disease appears most commonly on turf growing in direct sun, such as exposed slopes, along paths, driveways, etc. If a magnifying lens is used, a black mold may sometimes be seen growing on the grass blades. The disease is most common on various fescues, annual and Merion bluegrasses, and especially creeping and velvent bents.

Control: Apply phenyl mercury up to 3 times weekly, depending on severity. Use $3/4$ to 1 oz. of the 10 percent active ingredient, or equivalent, in 10 gallons of water per 1,000 sq.ft. May combine phenyl mercury with cadimum-containing fungicide where desirable. Apply during hot weather in the early evening, but only if the temperature is expected to remain at below 85°F. for the following 12 hours, or injury may result. Acti-dione, Acti-dione RZ and Kromad have also proven effective. Follow the manufacturer's directions.

3. Brown Patch - During periods of high temperatures (minimum of 70°F. at night) and high humidities, more or less round patches of grass up to several feet in diameter are attacked. The grass is first water-soaked, soon turns dark and the leaves wilt. Later, when the grass dries out, it becomes a light brown color. The disease may spread rapidly. The turf is thinned and the older leaves kille. Generally only the leaves are killed and after several mowings the turf may look normal again, but thinned. When brown patch is "active", in hot, humid weather, a smoky-gray to black border of wilted, webbed grass may be seen in the early morning bordering the brown diseased areas. Brown patch may be evident when the soil temperature is 60°F. or above under certain conditions - usually when the grass is soaked - regardless of the temperature or the humidity. Under these conditions the disease is not active in the sense that a smoke ring is formed, but appears as slightly off-color turf areas. The disease is far more serious on golf greens than in higher-cut grasses. Colonial bents are generally much more severely attacked than creeping or velvet bents.

Control: Often kept in check by preventive measures including: (1) Avoid use of excessive amounts of high-nitrogen fertilizers which promote a soft, lush growth of grass. Apply nitrogen frequently, but in small

amounts during the summer months. (2) Water early in the morning, or shut off the sprinkler in time for the grass to dry off before nightfall. Avoid overwatering. (3) Provide better air drainage by careful pruning of trees and shrubs around pocketed turf areas. (4) Provide drainage for low-lying areas where water may stand. (5) Pole, hose or drag early in the morning to remove the dew - this is a most important practice for it eliminates the moisture necessary for spread of the brown patch fungus.

For chemical control, spray weekly, just before and during hot, humid periods using $1\frac{1}{2}$ to $1\frac{3}{4}$ oz. of a mercury chloride compound; 2 to 3 oz. of thiram, or a reduced mixture of each (e.g. $\frac{1}{2}$ oz. Calo-clor, or 1 oz. Calocure, plus 2 oz. Tersan 75) in 5 gals. water to cover 1,000 sq.ft. Mercury chlorides are generally considered more effective than thiram, but may cause injury when applied during hot weather. The reduced mixture of each is being more widely used each year as it results in excellent disease control, little or no injury and results in excellent color. Calocure is safer to use than Calo-clor. Thiram (Tersan 75) should not cause injury at temperatures normally encountered, even when "over-dosed". Additional applications will probably be needed following moderate, or heavy rains. Kromad and Auragreen will check active brown patch when two applications are made two days apart. Acti-dione RZ has looked promising in recent tests. When planting new greens use tolerant bents where possible: Pennlu, Washington, Arlington, Dahlgren, Cohansey, etc.

4. Dollar Spot Round bleached spots about the size of a silver dollar on creeping bent turf. When active, a fine white mold may bind grass blades together. The disease is active in moderately warm, moist periods in the spring and fall. Spots may be so numerous at times that they run together, forming large, irregular, bleached, sunken areas, which take several months to heal. Less dollar spot is usually found where the nitrogen level for vigorous growth has been maintained, regardless of the fungicides used. If active, spray before mowing as the disease is spread by infected clippings.

Control: Spray monthly in March, April, May, September, October (and sometimes early November) using a cadimium-containing fungicide. Infected turf should recover quickly (if properly fertilized) when prompt action is taken, otherwise the disease may be evident for a month or more. Other chemicals which are less effective, but may be substituted for cadimium are: phenyl mercury 1 oz./1,000 sq.ft. applied weekly; mercury chlorides 1 oz. at two-week intervals; Kromad 3 oz. at 2-week intervals; or Acti-dione RZ, following the manufacturer's recommendations. When planting new creeping bent greens check into the more tolerant strains available, such as Congressional, Arlington, Pennlu, etc.

5. Snow Mold, Scald - Irregular, dead, bleached areas in late winter, where snow is slow to melt. May occur during cold (28-42°F.) weather, when wet, in the absence of snow. A dense, dirty-white, bluish-gray, pinkish or black mold growth covers patches of turf varying from two inches to several feet in diameter; usually found growing and spreading outward at the edge of melting snow. Spots may be visible up to several months later. Snow mold is most severe in places that are low, wet, shaded from the winter sun, or otherwise have a deep snow and ice covering for a long period. Where the grass has been left long the dead grass forms a thick, crustlike mat. Most lawn and fine turf grasses are susceptible. Creeping bents, especially Seaside and Toronto, are more susceptible than Colonial and velvet bents. Congressional, Washington and Old Orchard bents have some resistance.

Control: Apply phenyl mercury or mercury chlorides spray just before the first heavy snow (or cold, wet period) is forecast in late fall or early winter. Repeat on problem areas during a mid-winter thaw. Use phenyl mercury (10% equivalent), 2 oz. per 1,000 sq.ft., or mercury chlorides 3 oz. in 5 to 10 gallons of water. Avoid fertilizing after September 15 in north-central states. Grass should not go into winter in a "lush" condition. Repair damage by early raking, topdressing and fertilization. Reseed or plug as necessary.

6. Pythium, Grease Spot, Spot Blight - Roughly circular, water-soaked spots about 2 inches in diameter, with a characteristic blackened, greasy border. Spots usually soon dry, becoming reddish-brown in color. If favorable conditions (very hot and moist) persist, spots often run together to form streaks, for the disease is apparently spread by mowing, or by flowing water. Grass growing in heavy, poorly drained, water-logged, compacted areas during hot, humid weather (85-110°F.) Various bents, fescues and ryegrass are very susceptible.

Control: Allow for adequate surface drainage, lynch or more every 10 ft. when laying out new turf. Provide better air movement by judicious pruning of trees and shrubs around pocketed areas. Avoid overwatering and heavy applications of nitrogen during hot, humid weather. Follow same cultural practices as given for control of brown patch. No completely satisfactory, simple chemical control is known. Rhode Island research has shown that Auragreen and Kromad will stop active Pythium when two sprays are applied, two days apart. Mixtures of phenyl mercury, mercury chlorides, thiram, Acti-dione RZ, and cadmium-containing fungicides have given control in Oklahoma. Follow local recommendations.

7. Damping-off, Seed Rot, Seedling Blight - Seeds rot, poor thin stands. Seedlings stunted, yellowed, may topple over in irregularly-shaped patches. Surviving plants are often weakened, and stands are slow to fill in. All types of grasses are attacked. Usually associated with excessive watering after seeding, but may be serious where the water supply fluctuates. Late spring or early summer seedlings are usually most severely attacked.

Control: Use highest quality seed of high germination. Treat seed with captan or thiram seed protectant. Avoid overwatering after planting, especially on heavy, poorly drained areas. Fall seeding is usually preferred. An application of mercury chlorides (1 oz.) or thiram (6 oz.) in 2½ to 5 gallons of water per 1,000 sq.ft., sprayed on just after planting has proven effective in many cases as has applications of Kromad and Auragreen. Applying Vapam 4-S, as recommended, before seeding may prove beneficial.

8. Melting-out - Affected creeping bent areas have a smoky-bluish case which later turns yellow just before the plants die. May cause large, irregular dead areas in fine turf. Yellowing and turf killing may occur without the smoky-blue case. Turf fails to recover because the causal fungus rots the roots. The disease occurs at the same time when Brown Patch, Curvularia and Pythium are apt to be active (75 to 105°F.). The disease is favored by abundant moisture and high nitrogen levels.

Control: Use the same chemicals as for Curvularia. Acti-dione RZ and Acti-dione-Ferrated have given the best results. Follow cultural control practices as for Brown Patch and Pythium.

9. Fairy Ring, Toadstools, Puffballs - Small to large, more or less circular, narrow rings of greener grass, sometimes with a ring of drying grass surrounding this zone of stimulated growth. Rings of toadstools (mushrooms) or puffballs may appear following wet periods (or heavy watering) during the spring, summer or fall. Localized "dry patches" in greens may actually be areas infested with the mycelial "spawn" of one of these fungi. Found equally on fine turf and in higher-cut grasses.

Control: No very satisfactory control measures have been developed. Suggest: applications of dolomitic limestone or magnesium salts where soil is quite acid. Aerification and "deep forking" to break up the dense fungus growth in the soil should be done. Water affected areas liberally, since the grass is dying from a combination of lack of moisture and nutrients. Applying dilute soil drenches to aerified and forked areas, using the same fungicides are given for dollar spot, should give partial control especially when a wetting agent (e.g. Triton) is added. In the Pacific Northwest, phenyl mercury, 1.5 oz. of 10% equivalent, plus wetting agent, applied at monthly intervals, has given good results. Drenching with iron sulfate (1 lb. in $1\frac{1}{2}$ gallons of water) or weak solutions of mercury chlorides have given control in England, when two applications are made, two weeks apart.

10. Algae - A green to dark blackish scum which may smother and kill turf in low, wet, shaded, or heavily tracked and compacted spots. When affected areas become dry and matted, algae form a thin, black, crust which later cracks and peels. Occurs where turf is thin or bare. Not strictly a disease.

Control: Allow for adequate water drainage (see under Brown Patch and Pythium), aerate and topdress with coarse material. Keep turf maintained in vigorous condition. Where necessary apply a dilute spray of copper sulfate (2 oz./1,000 sq.ft.), hydrated lime (2 lbs. /1,000 sq.ft.) as a dust, or liquid lime sulphur ($1\frac{1}{2}$ gal./1,000 sq.ft.) to affected areas.

11. Slime Mold - White, gray or yellow slimy globs grow over grass surface. These masses dry to form bluish-gray, black or white powdery growths which may smother or shade the grass blades in patches. Occurs following heavy rains or watering on both fine turf and higher-cut grasses. Not parasitic to the grass or considered serious.

Control: Rake affected areas and wash down.

12. Nematodes - Turf may lack vigor, later become thin and exhibit a "melting out" or die-back condition. Irregular patches of densely tufted yellow-green turf appear chlorotic with or without occasional bare areas. Grass blades dying back from the tips may be interspersed with apparently healthy ones. As damage continues, the grass responds less and less to fertilizer and water. Finally the turf will show serious wilt. Various symptoms of malnutrition and severe loss of vigor of both above and below ground parts. Nematode feeding wound may lead to severe injury by root-rotting fungi. Injured turf may be confused with drouth injury, fertilizer burn, improper water relations, poor soil aeration, disease, insect injury and possibly other complexes of various factors.

Control: Keep grass growing as vigorously as possible by carrying out recommended cultural and fertilization practices. Where laboratory tests

have indicated heavy populations of parasitic species, apply soil drenches of Nemagon, V-C 13 Nemacide or Nemakril, following the manufacturer's directions. Follow local recommendations. Sterilize (fumigate) the plant bed, and topdressing materials, using methyl bromide, D.D., E.D.B., chloropicrin or Vapam 4-S, following local or manufacturer's directions.

13. Powdery Mildew - Grayish-white patches of mildew appear chiefly on the upper leaf surface in shaded, poorly-drained areas. Infected leaves may turn yellow, shrivel and die. The disease is most common on Kentucky bluegrass, but attacks many grasses. It is usually a minor pest.

Control: None usually required. If practical, dust or spray with sulphur, Mildex or Karathane. Repeat in 10 days if necessary. Fertilize and water to maintain vigor.

14. Rust - Yellowish-orange, or reddish-brown pustules on leaves, leaf sheaths and stems. Serious only on Merion bluegrass during hot, dry weather. Infected grass blades turn yellow and shrivel, thin out and winter-kill. Masses of reddish spores may collect on shoes or white objects.

Control: Fertilize with nitrogen (granular urea, Nugreen, etc., using 1 - 2 lb. per 1,000 sq.ft.) about two weeks before disease expected). Water during hot, dry weather so grass blades grow at least an inch per week. Where Merion is mowed weekly, rust is no problem. Spraying at two week intervals using zineb, maneb, or Acti-dione have given fair results. Repeat applications 7 - 10 days will be necessary.

TURF FUNGICIDES

<u>Fungicide</u>	<u>Trade Names</u>
1. mercury chlorides	Calo-clor, Calocure, Calagreen, Bi-Cal, Fungchex, Woodridge Mixture 21.
2. cadmium compounds	Cadminate, Crag 531, F-531, Puraturf 177, Caddy, Caddy-Plus
3. thiram	Tersan 75, Spotrete, Arasan 75, Panoram, Link's Thiram, etc.
4. phenyl mercury	PMAS, Puratized Agricultural Spray, Tag, Liquephene, Turfgrass Fungicide, EM, EMIS, Merbam, PMA Solubilized #10, Puraturf, Tat-C-Lect
5. cycloheximide	Actidione-Ferrated, Acti-dione RZ, Acti-tabs
6. maneb	Manzate, Maneb, Fungicide, Dithane M-22
7. dichlone	Phygon XL, Niagara Phygon, Corona Phygon XL Micronized
8. zineb	Parzate Zineb Fungicide, Dithane Z-78, Fungicide A, Blightox 65-W, etc.
9. dinitrocaprylphenyl crotonate-	Mildex, Karathane WD
10. captan	Captan 75 Seed Treater, Orthocide 75 Seed Protectant
11. PCNB (pentachloronitrobenzene)	-Terraclor, Acti-dione RZ
12. malchite green	Auragreen, Kromad

13. broad-spectrum turf fungicides - Kromad, Acti-dione RZ
14. nematodes Nemagon, VC-13 Nemacide, Nemakril
15. soil and topdressing sterilants Methyl bromide, D-D, EDB, Vapam 4-S, chloropicrin, Larvacide, Bromex, Dowfume MC-2, Dowfume W-85, Dow Methyl Bromide Odorized with Chloropicrin, Nemex, Nemex-40, Nemex-85, formaldehyde, etc.

How to Collect and Send Turf Specimens for Disease Analysis

Using a 2" or 4" plug cutter, take 2 or more samples (2" deep) from the edge of the active disease area and from nearby apparently healthy turf. Wrap each immediately in aluminum foil, or polyethylene, to keep from drying out, but not wax paper. Pack samples tightly in an ice cream carton, soil mailing tube, etc., and mail to your Agricultural Experiment Station, in care of the Extension Plant Pathologist. Attach a letter to each sample, stating the past history, or other vital information: date collected, grass attacked, owner or operator of property, location of property, collector, area of injury, prevalence of damage, degree of injury, recent fertilization, watering or pest control practices, etc.

BLUEGRASS RUST STUDIES

Michael P. Britton

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(Presented before General Turf & Golf Course Groups M.R.T.C)

The Purdue Turf Disease Project was begun in the autumn of 1955 to provide basic information on the behavior of the pathogens inciting diseases of bluegrass and to develop effective controls for the major bluegrass diseases. During this period much of the emphasis has been placed on a study of stem rust of bluegrass caused by a fungus named Puccinia graminis Pers. This is the same species of fungus which causes black stem rust of the cereal grains and many other grasses.

It has been known for many years that Kentucky bluegrass would be attacked by stem rust occasionally. These sporadic attacks were relatively light and the disease was never considered an important one until it was observed in epidemic proportions on Merion bluegrass in 1953. Oddly enough, the stem rust attacking Merion did not appear to be morphologically identical with the stem rust variety which had previously been found on Kentucky bluegrass.

A study of the host range of the rust was made in order to facilitate more exact identification. Greenhouse inoculations showed that 39 grass species in 15 genera are susceptible to infection. Twenty-one of these are species of bluegrass (Poa). No definite conclusions have been reached con-

cerning the varietal status of the rust on the basis of its host range. The decision of its varietal identify has been postponed pending the completion of a comprehensive morphological study.

In conjunction with the host range study, a number of selections of Kentucky bluegrass and hybrids between species of bluegrass were tested for resistance to stem rust. Several selections with good resistance were found. Further study of the resistant selections is being carried out cooperatively with Dr. R.C. Pickett, who is in charge of the Bluegrass Breeding Program at Purdue.

Observations made at the Purdue turf plots and in scattered areas in northern Indiana, indicated that Merion bluegrass, grown under high fertility management, was only slightly rusted, whereas Merion managed at low fertility was heavily rusted. These observations support those reported by Carl Habenicht and Ben O. Warren, (Midwest Regional Turf Foundation Conference Proceedings, 1955) and others. A possible explanation for this phenomenon is that Merion, when adequately supplied with fertilizer, especially nitrogen and water, it simply produces new leaves which grow for 10 days before rust pustules show, thus masks over and modifies the rust infection. Field studies will be carried out to determine the effectiveness of this type of rust control and the best type of management program needed to effect control.

As complete rust control probably cannot be achieved through management practices alone, a program for evaluating fungicides for rust control has been started.

NITROGEN FERTILITY RESEARCH

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(Presented before General Turf & Golf Course Groups of M.R.T.C.)

The most important single fertilizer element required for the production of desirable turf, so far as amounts used, is nitrogen. Nitrogen is used in large quantities for the development of young, succulent tissue, and is readily lost from the soil by leaching and denitrification. Repeated light applications are usually necessary because nitrogen cannot be effectively stored over longer periods as well as sulphur, calcium, phosphorus and magnesium.

The frequency of light nitrogen applications, including the additional labor and capital involved, often causes nitrogen fertility costs to be one of the most important items of turfgrass maintenance. Nitrogen containing materials differ in their relative rate of nitrogen release and the length of effective residual action. Our turf fertility research has been critically examining several different types of nitrogen carriers under a variety of field conditions, and in closely controlled greenhouse management. This is offered as a progress report, since the research has not been terminated, and the results are tentative.

Fairways

An extensive fairway fertility experiment initiated in the early spring of 1956, demonstrated that the beneficial effects of a good nitrogen fertility program could persist throughout the season following a single spring application. March 10 applications of calcium cyanamid produced lush spring growth, followed by good mid-summer turf quality. The nitrogen effect did not, however, persist through the fall season. The improved mid-summer turf quality may have been due to a removal of chickweed by the cyanamid and an increased vigor of the bluegrass. Lighter applications in May damaged the turf wherever distribution was below optimum. The effects of the May applications lasted no longer than the March treatments. Therefore, applications of cyanamid can best be made early in the season with less chance of damaging the turf while producing similar desirable improvements in turf quality.

Light applications of urea in April produced a very quick nitrogen response, while the soil was moist and the temperatures were cool. By the middle of summer most of the fertilizer value of the urea had been used by the turf, or had been leached by late spring rains.

April applications of activated sewage sludge produced desirable turf responses for five weeks with the heavier (four pounds of nitrogen per 1,000) rate giving an additional four weeks response.

Corn gluten responded similarly to activated sewage sludge except that it produced a faster early response, and a five pound rate applied in April continued to produce improved turf quality throughout the growing season.

Three commercially available ureaformaldehyde fertilizers were applied in April at 2, 4 and 8 pounds of nitrogen/1,000 sq.ft. The high rate produced improved turf quality during the whole season with noticeable effects in late fall. The 4 pound rate produced adequate growth through August, but no real effects were observed in October. The 2 pound rate in general was not effective, except by the materials containing higher amounts of soluble nitrogen. Based on these observations, medium or heavy rates of ureaformaldehyde are required to obtain a longer residual action. The relative merits of one versus two applications are now under study. Some differences between products were observed, although they were of minor importance.

The clipping yields and nitrogen content in the leaves remained higher longer than did the visual turf quality. This phenomenon occurred for all treatments.

The specific nitrogen fertility program is dependent upon the previous management of the fairway, the quality of turf desired, the length of the growing season, and the water supply. Light fall and spring applications of soluble materials are sufficient for lower fertility areas and those not receiving irrigation. The nitrogen response can be extended farther into the summer by late spring applications of organic type fertilizers. The longer lasting effect of the ureaformaldehyde materials can most advantageously be used on irrigated fairways where superior turf is desired. Under these conditions higher rates are needed.

Greens

A trial initiated in the fall of 1955 designed to compare representative samples of the various types of nitrogen fertilizers on putting green turf, has given some valuable experiences in putting green fertility research. Difficulty was experienced in predicting amounts of fertilizers required to give an adequate comparison of the various types, and once these rates were selected, large differences in turf quality developed.

The soluble type fertilizers produced very fast responses even at low rates of application. Five pounds of nitrogen per 1,000 sq.ft. during the season was not sufficient for maximum turf quality for any material because the responses did not persist from one application to another.

The organic type carriers produced a more uniform response between applications. A total of 6 pounds of nitrogen per 1,000 sq.ft. as organics was not adequate for the entire season. Little differences were noted between corn gluten and activated sewage sludge when applied at equal rates.

The ureaformaldehyde fertilizers produced the long lasting effects only when applied sufficiently heavy. During the last season 9 pounds of nitrogen per 1,000 sq.ft. was a minimum requirement. Lower rates (6#/1,000) were insufficient for the season. No damage from heavy applications during fall and spring has been experienced. However, materials containing higher amounts of free urea, or short chain methylene ureas caused some temporary burn when applied at rates of 12 pounds of nitrogen per 1,000 sq.ft. during hot weather. It is felt that a ureaformaldehyde fertilizer program must use at least 8 pounds of nitrogen per 1,000 sq.ft. per year to effectively capitalize on the ureaformaldehyde advantages of longer action and relative freedom of burning from higher rates.

Greenhouse Studies

To more closely measure some of nitrogen effects on turfgrass, a series of greenhouse turf trials are being conducted. Ryegrass turf is being maintained at various levels of nitrogen fertility and the condition of the turf is being evaluated as the effects of the fertilizer dissipate.

Last year's experience indicated that urea compared very favorably with organic fertilizers whenever leaching was prevented. Without leaching losses, a higher percentage of nitrogen was recovered in the clippings of urea treated turf than from any other treatment. The organic materials were very similar in turf response with the effects upon clipping weights and nitrogen content persisting for 6 to 9 weeks after fertilization.

High variation was found in the ureaformaldehyde materials tested. The amount of early growth response was associated with the availability index. Those materials with a high availability index responded most quickly since they contained higher proportions of water soluble components. The materials with lower availability indices produced a slower initial effect and in some cases did not have a longer effect. Materials with availability indices of 40 or above, were found to have satisfactory fertilizer properties.

Current Research

During the approaching growing season the research program is being improved by emphasizing the effects upon turf quality rather than clipping weights and nitrogen recovery rates. The trials are being expanded to include improved bluegrass lawns, warm season grass fertilization, and the effect of fertility levels upon disease damage. Such information will be of real value to the professional grower of turf as well as those persons in pure research.

SOIL TEST SUMMARIES SHOW TURF NEEDS

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(Presented before General Turf and Golf Course Section of M.R.T.C.)

Plants have a lower limit as to the nutrients they may contain and yet appear healthy - this we call minimum. Below this we see visual signs of deficiency on live plants, such as yellowing, firing, dieback, etc. Above deficiency most plants have a range of element content which allows for, and is called, normal growth. If the uptake by roots of the plant is excessive, due usually to excess of a nutrient in the root zone, then we have toxicity; therefore, much of plant nutrition and fertilizer usage is an attempt to avoid deficiency, assure and maintain adequacy, yet prevent toxicity.

Both plant tissue tests and soil tests have been developed and utilized to assay the soil supply, to predict utilization, and to provide a balance of nutrient elements. In this story some of the needs of turf, as shown by a summary of soil tests, will be pointed out.

At Purdue University the Soil Testing Laboratory tests approximately 40,000 samples per year. This report covers only the 812 turf soil samples referred to my desk between 1952-1956 because of questions asked, or supplemental information needed. Since the Laboratory accepts turf soil samples from midwestern states, this report covers general conditions of the Midwest.

We have been concerned whether some fungicides or herbicides being used would affect soil test results. A suspension of tersan (thiuram disulfide) equal to a full season application (about 5#/1,000 sq.ft.) had no effect on P or K tests. The arsenic element gives a blue color test similar to phosphorus; however, the test is much less sensitive to arsenic. Heavy concentration of arsenics in some test samples gave only medium readings. Since the 369 putting greens samples included greens with and without arsenic, depending on the insecticides used by the superintendent over the past ten years, the uniformity of excess levels indicated arsenic did not predominate over the phosphorus measured. Thus, it appears the tests are measuring the P and K contained in an available form.

Do Many Turf Soils Need Lime?

A pH of 7.0 is neutral, i.e., a balance of Ca and H ions. On soils below a pH of 6.0 (which indicate 10 times more H ions than at 7.0) lime applications are encouraged. The pH is readily affected by the hard (calcium carrying) irrigation water used in much of the Midwest. Therefore, many samples show slightly alkaline (above a pH of 7.0). If supplies of other nutrients, particularly potassium, are maintained at adequate levels, turf grows well. In alkaline conditions, the supplies of other nutrients, particularly potassium, should be maintained at adequate levels.

Table 1. pH of 369 Midwest Putting Green Soils

below 6	6.1-6.4	6.5-7	7.1-7.4	7.5 above
<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
3	6	35	43	13
9% might need lime		91% don't need lime		

Table 2. pH of 84 Midwest Golf Course Fairway Soils

below 6	6.1-6.4	6.5-7	7.1-7.4	7.5 above
<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
27	16	30	21	6
27-43% need lime				

Table 3. pH of Midwest Lawn Soils

	below 6	6-7	7.1 above
	<u>%</u>	<u>%</u>	<u>%</u>
222 established	15	40	45
102 to be planted	40	35	25

On considering all these established lawns, only 15% needed lime. On new lawns 40% needed lime. If possible consult your agricultural leaders to get a soil test before devoting effort or funds to liming.

How About Phosphorus and Potash Needs?

Table 4. Phosphorus and Potash in 121 "to be planted " lawn areas.

	V.L.	L.	M.	H.	V.H.	Excess
	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
Phosphorus	17	27	22	14	11	9
Potash	31	45	11	9	4	-

Notice the need for both elements here is about equal. Since grass responds most to nitrogen, then a 1-1-1 ratio is often desired for mixing into the root zone before planting grass seed.

Table 5. Phosphorus and potash in 205 Established Midwest Lawn Soils.

Test	V.L.	L.	M.	H.	V.H.	Excess
	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
Phosphorus	1	5	10	9	21	54
Potash	7	30	17	20	26	-

Of the established lawns, only 6% might respond to additional phosphate materials, but 37% would probably respond to potash with most irrigated lawns showing alkaline in pH, a higher availability of potash is desired for balance of Ca-K. Therefore, potash needs for availability, plant use, and balance should have additional attention.

Table 6. Phosphorus and potash in 369 Midwest Putting Green Soil Samples.

Test	V.L.	L.	M.	H.	V.H.	Excess
	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>	<u>%</u>
Phosphorus	0	0	1	1	6	92
Potash	9	31	30	17	16	-

How can 99% have high to excess phosphorus? The potato growers of Maine, fruit growers of Washington and tobacco growers of North Carolina have also, by repeated heavy application of complete fertilizers, accumulated high phosphorus levels in their soils. Remember, fertilization was started as a supplement to natural soil content - and fertilizer manufacture was built around phosphorus acidulation. Therefore, there is a strong trend on maintaining high proportions of phosphate in mixed goods. Nevertheless, since there is repeated fertilization of turf area, very little phosphate may be needed to maintain high availability levels.

Potash, to the contrary, is easily leached by hard water used in irrigation. Frequent use of urea or ammonium sulfate replaces the potassium from the soil colloids. Watering then leaches the potassium out of the root zone. Frequent clipping and removal of clippings cause a steady drain on nutrients, particularly nitrogen and potassium. (Table 2.) Accordingly, on most irrigated Midwest turf areas more potash is needed. All putting greens

showing medium or lower (70% of total tested) have had some potash applied, yet not enough to maintain adequate levels. (Table 6).

Table 7. Phosphorus and Potash in 81 Midwest Fairway Soil Samples.

Test	V.L. %	L. %	M. %	H. %	V.H. %	Excess %
Phosphorus	2	23	14	11	14	36
Potash	9	25	15	24	27	-

In medium, or lower, availability the fairway tests for P and K are similar. Actually these tests represent two extremes. -Those not fertilized in years, and those high in both P and K due to adequate current fertilization. Irrigation of fairways should double nitrogen and potash needs, but have little effect on phosphorus needs.

FACTORS IN SELECTING GRASSES

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This section has to do with nurseries, cemeteries, industrial lawns and roadsides. In considering establishment and maintenance of grass in these categories, there are certain basic principles that are fundamental to successful operations. In each category, there are certain goals to which we aspire. There are certain objectives that must be kept in mind, for instance, in a commercial grass nursery, the grasses that are offered for sale must be carefully selected for their acceptance by the public, for their appearance, for their ease of growing, for their disease resistance, with everything geared to successful establishment by the customer.

In cemeteries, grass is desired that gives the minimum of trouble, that needs the minimum of trimming, and doesn't need mowing until after Memorial Day. The late Cliff Runyan often said that he liked Zoysia in his cemetery in Cincinnati because it didn't need mowing but once or twice before Memorial Day. Turf in a cemetery should always be green with the minimum of weeds and best appearance at all times.

Industrial lawns are established mainly for appearance. Here again, they should always be green, dense and weedfree. Height of cut is no serious objection. On roadsides, low maintenance, or no maintenance is the objective, with vegetation that can successfully compete with weeds; in fact, can crowd them out - vegetation that will take care of itself with no erosion and no upkeep expense, yet giving excellent protection and appearance at all seasons of the year.

Regardless of the category, the selection of the grass is utterly basic to success. The grass must be suited to the soil, to the climate, to the management that it will get, and to the use of the area. Grasses should be selected for high disease resistance, drouth tolerance, insect tolerance and, of course, wear resistance wherever there is wear.

In this discussion, the term "drouth tolerance" is meant to cover those factors which may be called drouth tolerance, or drouth resistance. It is recognized that there is a difference between these terms, but for the purpose of this discussion, drouth tolerance covers all. Under certain conditions, grasses must be suited to certain height of cut to meet the needs of a particular use.

In commercial nurseries, these grasses appear to be the most prominent in this area. Merion Bluegrass outsells all other kinds of bluegrasses as sod. One grower in Toronto, Canada, hauls Merion bluegrass sod to Chicago in order to try to meet the growing demand for this type of sod. The resistance of Merion to drouth, to wear, to close mowing, to heat and to leaf spot, which seriously affects many other types of Kentucky bluegrass, makes it a prime favorite for many uses, including golf course tees, fairways, approaches, collars, lawns and other areas. Among the bentgrasses, stolons of Pennlu, Arlington, Congressional, Toronto, Cohansey, Washington and Old Orchard, are being grown and sold. Each has its specific limitations, yet under good management any one of them can produce a good putting green. Penncross Creeping Bent seed is becoming more widely available and is producing a superior type of putting green turf. Creeping Red Fescue, or Red Fescue of any kind, in the Midwest area, leaves something to be desired, yet the new Pennlawn is a superior variety. It is available.

Among the tall fescues, Kentucky 31 seems to give superior performance to either Alta or Goar's, particularly here in the Midwest. This is not necessarily true on the West Coast, or in the Pacific Northwest. On athletic fields a 3 parts Kentucky 31 and 1 part bluegrass is widely used.

Among the Zoysias, Meyer zoysia is a favorite in the southern part of the region, but does poorly further north where the growing season is short. Emerald still does not pass the "sit"-ability test because it is prickly through the clothing when one sits on it.

Among the Bermuda grasses which are steadily moving northward are U-3, Sunturf and Ugandagrass. Each has its specific place and comparisons of these three types have been made and soon will be available in a mimeographed leaflet.

Some cemeteries have developed large areas of Merion Bluegrass, both for sod and for lawns. The sod is easy to move and makes a wonderful appearance. In some cases, Kentucky 31 fescue is being used in conjunction with Merion bluegrass, but here it is necessary to seed rather heavily using up to 80% of the mixture as Kentucky 31 fescue, in order to get the plants close enough together so that they do not become bunchy and objectionable. Even ryegrass becomes bunchy and objectionable if the plants are far apart and allowed to develop individually.

For industrial lawns, Kentucky 31 bluegrass mixture, including

Merion, of course, seems to be a prime favorite. Here the height of cut can be 2, 2½ inches or higher with ample fertilization, and we have a combination that is more likely to be green the year round than almost anything else we know.

On roadsides, it is a different story. Here we find tall fescue becoming a prime favorite for roadside planting, where mowing is to be done, because it is so rugged, grows over such a wide territory on so many different soil types and at rather low levels of fertility. But, on the cut and fill slopes, Kentucky 31 fescue does much better when it is combined with a good legume such as Penngift Crown Vetch. In many cases the Penngift Crown Vetch will spread and tend to choke out the grasses, but according to Penn State Bulletin #576, the Crown Vetch when once established produces a cover that excels the best of the perennial grasses in persistence and quality of slope protection with the root systems being deeper than those of the grasses and providing better soil binding. It is of importance to note also that the combination of a grass mixture with Crown Vetch will develop a cover that is so weedfree that spraying for weeds becomes unnecessary.

For greatest resistance to wear, nothing can compare with Bermuda grass, if it is adapted. Next would come the bluegrasses, particularly Merion bluegrass, when it is adequately fed. This brings up the subject of fertilization.

Fertilization is one of the best weed control devices known. It also helps the grass to make more efficient use of water. Grasses will stay green longer through a drouth if they are adequately fertilized; they recover more quickly from injury and resist the attacks of diseases and insects to a greater degree. The trend in fertilization is toward fertilizer mixtures containing all of the elements necessary for plant growth, blended in proper proportions, and using several different forms of nitrogen, including Urea-form nitrogen, which is the longest lasting and safest form of nitrogen known.

Some of the questions that followed the discussion deserve a place here.

Q. Is anyone working on a finer leaved tall fescue? What stage are we at?

A. Yes, something is being done about developing finer bladed tall fescues. One such fescue is in preliminary stages and is being used at a cemetery in Cincinnati. It resembles very much Kentucky bluegrass, but is much more disease resistant. We do not yet know how tolerant it is of close mowing.

Q. Is Mondograss a good lawn grass for this area?

A. Apparently Mondograss grows best in Biloxi, Mississippi, where produced and advertised.

Q. What could I grow on a steep, southwest slope where the sun beats in and where I have great difficulty in growing any kind of grass? This is rather a tall slope and I would rather not mow it.

A. Apparently your slope can best be held by seeding a mixture of Kentucky 31 fescue and Crown Vetch.

Q. Do you recommend mulching a new seeding?

A. In most cases, yes. Mulch holds moisture and more nearly insures a good catch of seed. It also prevents erosion and limits traffic.

Q. Is a mixture of 80% Kentucky 31 and 20% Merion bluegrass good for athletic fields?

A. Yes, particularly if you will maintain a high fertility level, especially nitrogen. Use 100 - 150 lbs. Kentucky 31 per acre.

Q. I am planning to seed the fairways of a nine-hole golf course. I would like to use a mixture of Kentucky bluegrass, Merion bluegrass and Astoria bent. Would you approve of this?

A. Yes, I take it that your fairways are not going to be watered. If you maintain a high fertility level and mow at about 3/4" you should have good fairways.

Q. Which is worse - leaf spot on Kentucky bluegrass, or rust on Merion bluegrass?

A. Most of the experts feel that rust is the lesser of the two evils. The leaf spot hits Kentucky bluegrass early in the spring when it is cool and moist and weakens the plant so that the turf is easily invaded by crabgrass and other summer weeds. Rust hits Merion bluegrass in the latter part of the summer and rarely does any severe damage. Also, rust can be minimized by adequate fertilization and irrigation to keep the grass growing. Merion usually recovers 100% from an attack of rust at a time when there is little likelihood of the invasion of any weeds.

To summarize:

1. Choose your grass carefully, according to the soil, the climate, the management and the use.
2. Fertilize it adequately with complete fertilizers containing several forms of nitrogen, adequate phosphate, potash and other elements, including long-lasting Urea-form.
3. Keep the grass mowed at the proper height. Mow frequently for best results.
4. Irrigate, if possible, only when it is necessary. Too much water can kill grass and encourage weeds.
5. A good grass, properly fertilized, is still the best weed control.