PROCEEDINGS

of

1965 TURF CONFERENCE

Sponsored by the

and

PURDUE UNIVERSITY

LAFAYETTE, INDIANA

March 1 to 3, 1965

PROCEEDINGS OF THE

1965

MIDWEST REGIONAL TURF CONFERENCE

The 42 talks included in these Proceedings are condensations of talks by speakers before sections and divisions of the 1965 M.R.T.F. Conference. We appreciated the willingness of the speakers to participate and prepare material for your reading. See Table of Contents next page. Proceedings of each annual Conference since 1948 have been prepared. A limited number of 1960, 1962, 1963 and 1964 Proceedings are available at price below.

A copy of these Proceedings were mailed to:

1. The 576 attending the 1965 Midwest Turf Conference.
2. One person of each member organization within the Midwest Regional Turf Foundation not represented at 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

Check below for special articles suggested for first reference as based on your major interest.

For Lawns first see articles starting on pages -

8, 10, 15, 32, 34, 44, 47, 53, 54, 60, 63, 65, 67, 73

For Sod Production first see articles starting on pages

13, 15, 17, 24, 32, 34, 35, 36, 43, 44, 45, 47, 48, 51, 53, 54, 60, 61, 63, 65, 67, 69, 70, 73

For Golf Courses - all including

15, 17, 19, 21, 24 to 36, 38 to 44, 53, 65, 76

TABLE OF CONTENTS

BRIEF OF PRESIDENT'S REPORT

Richard B. Craig, Supt., Losantiville C. C.,
Cincinnati, Ohio

Another year has elapsed, the twenty-eighth Conference is well on its way to being over. We are in a time period when our local professional organizations are as numerous and as strong, through individual support, as ever before. We have had the state turf organizations come into being and subsequently a greater interest is being generated in the states for their own turf research and teaching programs. The national superintendent's association has made many advances and accomplishments. Sod producers have organized nationally. And yet, MRTF is as active and strong as ever. This is indicated by the number of members and the high attendance we have had at this educational Conference every year. This strength that MRTF has is only possible because of your individual enthusiasm and support, and for this we are very grateful. It is only through active support and participation that we keep all these organizations active and growing, and thus we learn and grow.

As President I would like to express a most sincere thanks to the man who keeps the organization going and makes this organization what it is today - Dr. Daniel. And also a well deserved thanks to Bob Seager, technician, and to our ever faithful Mrs. Kaye House.

It has been a privilege and a most appreciated honor to have served as President of MRTF for the past year.

- - - - - - - - - - - -

EXECUTIVE SECRETARY'S REPORT

W. H. Daniel, Dept. of Agronomy, Purdue

The by-laws state that the Executive Secretary and Treasurer shall be members of the Agronomy Department. This augments the agreement that Purdue University serves as a home and the essence of work occurs within the University. For 20 years this orientation has worked well, in fact, very well.

A regional educational program is only as good as its support. Our membership has plateaued above 360. Attendance at these Conferences has plateaued near 600. My trips to observe turf; to speak at meetings, and participate in programs averages 60 per year. Your individual interest in making these effective and meaningful facts is most appreciated.

With research, teaching, student counseling and extension work, there are always things to do. Nevertheless, your individual questions and needs for information certainly should be and are our major concern.

My thanks to many for your assistance and help in your local areas. The current Board of Directors have been most helpful.

- - - - - - - - - - - -

THE SIZE OF THE WORLD TODAY

Earl L. Butz, Dean, School of Agriculture
Purdue University

The long-run outlook for international agriculture is essentially one of a race against time and capital in an effort to meet the onslaught of a tremendous upsurge in world population.

The man-food ratio around the world - never high enough to be very exciting to two-thirds of the world's population - has actually been in a decline recently. Total food output has increased, but at a slower rate than population.

Those of us in North America, who wrestle with perennial surpluses of both food and feed grains, too frequently view our problem in the short run. While this may be important, it is high time that we begin to fashion our domestic programs and policies with a view toward the political and economic realities of the developing world food crisis. Although I use the word "crisis," it need not develop in our lifetime if we can apply the intelligence we possess to the twin areas of food production and international trade.

At the beginning of the Christian Era, world population has been estimated at around 250 million. In the next fifteen centuries it doubled, reaching 500 million by 1600. Three centuries later, by 1900, world population had tripled, and stood at about 1.5 billion. In less than two-thirds of a century since 1900, world population has approximately doubled again.. Reliable estimates indicate that in the little over one-third of a century remaining until the year 2,000, it will double again, and we will stand at about 6.3 billion people.

During the first fifteen centuries after Christ, the rate of increase in world population was estimated at .02 percent annually. By 1900 this was approximately 1 per cent. As of 1960, the annual rate was about 2 per cent, and it is expected to rise even above this figure for the remainder of this century. Obviously, this rate of growth cannot persist indefinitely, because of the sheer limitation of space and food. However, such a rate is within the realm of possibility within our lifetime. Therefore, face it we must.

The U.S.A. expects an increase of 60 per cent by the year 2000. Projected rates of increase are approximately the same for Western Europe and Russia. However, population in Latin America is projected to increase 188 per cent. Likewise, the African population increase is projected at 120 per cent, and Asia at 139 per cent.

Food Production Trends

From the beginning of history, man has always been in a struggle to feed himself, with the possible exception of the Western World in the last two or three decades. From the beginning of the human race until now, man gradually developed the food production capacity required to sustain 3 billion people on the earth, although many persons have a very meager available food supply per capita. If the 6 billion plus people predicted by the year 2000 are to be sustained, with no improvement in diet whatever, man will need to develop the capacity to feed another 3 billion people - and this must be done in the short term of one-third of a century. This means that we must duplicate in the next generation the production record that man has achieved since the dawn of history. And we must do this at a time when nearly all of the virgin lands of the world have been brought into production and when we face increasing inroads on arable

by the urban sprawl, developing highways, parks, recreation sites, and the like.

The challenge is great, but the situation is far from hopeless. The world's land surface is currently estimated at 32.9 billion acres. Of this, 3.5 billion acres, about 11 per cent, is classified as arable land and land in tree crops. We actually plant to crops considerably less in a given year, usually under 2.4 billion acres, about 8 per cent of the earth's land surface. We have another 6.4 billion acres, or 19 per cent of the earth's land surface, in permanent meadows and pastures. Thus, if we include this with crop land and tree land, we account for about 30 per cent of the earth's land surface. It is possible that some of the remaining 70 per cent may someday be brought into agricultural production, as capital becomes more plentiful, as cheaper sources of energy are developed, and as more efficient means of converting sea water to usable water become available.

There are only two possible answers to the problem posed above: (1) increased agricultural production world-wide, with sufficient trade flexibility to permit effective geographical distribution, and (2) a widespread and rapid increase in birth control practices. In the long run, say by the close of this century, birth control is the only solution. But this is developing extremely slowly in the population pressure areas of the world, and probably will continue to develop slowly because of low levels of education and living standards. Hence, the immediate need before us is to increase agricultural production and to work out more effective means for distribution of our foodstuffs - just the converse of some of the agricultural and trade policies currently popular in the United States and Canada.

Individual countries vary markedly in the share of land suitable for cultivation. Moreover, population and arable land are not at all evenly distributed. This accentuates the need for realistic trade policies. Asia, for example, has about 56 per cent of the world's people, but only 31 per cent of the arable land. Western Europe, likewise, runs behind in arable land. In most of the rest of the world the inverse is true.

Perhaps the greatest variation among the nations in agricultural productivity lies in capital inputs, particularly in the form of fertilizer, drainage, irrigation and technology. In this respect North America leads the world. The record of increased efficiency of production by North American farmers since the decade of the 1930's is northing short of phenomenal. It is meaningful to use the trend in per capita grain production as an indicator of both agricultural progress and the quality of diet. A majority of all calories consumed comes from grains, either directly or indirectly, after conversion into meat, milk or eggs. Thus a rising per capita output of grains in any population makes possible either a rise in calorie intake or the production of additional animal protein if this is needed or desired.

World grain output increased 47 per cent during the 25 years from 1934-38 to 1960-61. During this time total harvested area increased by 15 per cent and average yield by 28 per cent. However, there was tremendous regional variation. During that quarter century both North America and Oceania more than doubled total grain production. Eastern Europe and the USSR gained only 24 per cent, Western Europe 31 per cent, Asia 41 per cent, Latin America 42 per cent, and Africa, undisturbed by the war, 54 per cent. The latter increases did not keep up with population growth. North America expanded its share of world grain output from 16.7 per cent in the years 1934-38 to 22.8 per cent in 1961. During this same period the Soviet Bloc share of world output was steadily shrinking from 23.5 to 19.8 per cent. Or if we divide the world into the two dominant economic regions - developed and undeveloped - we discover that output in the developed regions increased 51 per cent during this period, while that in the underdeveloped regions increased only 42 per cent. This is significant when it is remembered that the rapid population growth is in the undeveloped region. The output of grain per capita of farm population in North America, more than trebled in the twenty-five years from 1934 to 1961. During the same interval it actually declined in Latin America and increased only modestly in Africa and Asia.

The transposition of the advanced mid-20th century advanced agricultural technology of North America into the underdeveloped agricultural areas of the world is, at the best, a very slow and arduous process. Yet, we must not despair in our efforts to build up the agricultural economies of the underdeveloped nations. To the extent that this can be done it will both promote economic and political stability within those nations, and will in part alleviate the burden that must inevitably fall on North American agriculture in the latter part of this century to prevent mass starvation in large areas of the underdeveloped world.

Higher Production Needed

We thus face the prospect a decade hence that the great bread baskets of North America will be called upon to supply food for large areas of the world until the population-food ratio can again be brought into approximate equilibrium. The latter cannot be accomplished quickly or painlessly. We, therefore, face the challenge, in North America, to keep our food production machine in a healthy state, fueled for a massive effort in the years ahead. We can add only a limited supply of additional arable land. We can get some additional food from the sea - but here again we face practical limits. The only practical alternative available to us is the accelerated application of capital and technology to our own agricultural system in an effort substantially to increase output per acre and per man. This means accelerated application and use of fertilizers, irrigation, better seed varieties, more pesticides, and extensive research inputs. We must not be lulled into a position of retreat on the North American agricultural front, because of current selective surpluses within our boundaries, because of uncertainties over the agricultural pplicies of the European Common Market, because of our declining numbers of farms and farmers, or because of the temporary rise of agricultural nationalism in many of the newer and undeveloped nations of the world.

Rather, we must view the tremendously efficient agricultural plant of North America as one of the most powerful tools in our kit of international diplomacy. And then, having viewed it this way, we must pursue more sensible internal price support and production control programs than have persisted in recent decades. Likewise, we must follow trade policies which are fitted more nearly to the economic realities of our times.

To prepare for less than this will be to condemn a large part of the world to widespread famine and political instability on a scale unprecedented in history. In modern times, our own two nations could not remain insulated from such a catastrophe on the other side of the globe, either east or south. Hence, there is no realistic alternative for us except to gear up to meet this challenge.

- - - - - - - - - - - -

SPACE AND TURF GROWTH: AN INTRODUCTION

Dr. Fred V. Grau, Agronomist
College Park, Maryland

It is a rare opportunity to introduce various concepts of Space and Turf Growth. Space is an interval between objects. Let us start to consider this by examining, in your mind's eye, the particles of matter in nuclear material which are so tightly packed that a solid piece the size of my thumb would weigh 60 million tons. Here space is at an absolute minimum.

Next, consider the atom, the building block of all chemical substances, which consists essentially of a nucleus surrounded by orbiting electrons which are in constant motion within a fixed space. As electrons are shared or exchanged with other atoms, we have molecules formed which maintain a certain space separating them from, yet joining them to, other molecules.

Now, another concept of space. Let's say we have produced one pound of breeder seed of a new superior bluegrass. (Breeder seed is the "MOTHER SEED" from which is produced Foundation seed, which, in turn, produces Certified seed). We will give 8 ounces to each of two reputable growers for increase of Foundation Seed. Both growers know how precious each seed is. Grower A has prepared a space of 8 acres of weed-free soil. He mixes the seed with cornmeal to increase the bulk, then plants one ounce of seed per acre in 3-foot rows with roughly one seed per inch of row. This sounds thin! But-

Grower B handles his 8 ounches of seed (about 1.25 million seeds) differently. He has a large farm, a large family, and lots of help. He plants his seed in a small specially-prepared,sterilized bed. As the seedlings emerge, he transfersthem to small peat pots, one to a pot. Allowing for reasonable mortality, he develops one million sturdy seedlings, each in an individual pot. How, what extent of space can he plant with rows 3 feet apart (space to cultivate) and seedlings spaced one foot apart in the row? Yes, he would plant 70 acres with plants developed from 8 ounches of seed. The two concepts of space just illustrated are real. Both have been done.

Now, let's skip through time to the point where Blue Tag Certified seed is on the market. You have bought 100 pounds of the seed. When planted too thick the seedlings would emerge so thick and so closely pressed together that there would not be sufficient space for growth. Diseases may run unchecked because the space between blades would be so small that the organisms would have a continuous growth medium. As each seeding would start, then fail, you would be encouraged to overseed again. Modern recommendations that recognize the need for space between plants for maximum expansion would say to cover 2 acres, sometimes more, with the hundred pounds of seed. With ample supplies of nutrients in the seedbed,each seedling quickly would occupy its allotted space to provide the desired density of turf.

Many early Penncross putting greens were called failures because some architects insisted on using 6 pounds of seed to 1,000 sq. ft. This figures out to 44,000 seeds per square foot. The space was so tightly packed with seeds that the seedlings had no space in which to grow. Today no one would think of using more than 1/2 to 1 pound of seed per thousand which is still plenty, but it does allow some space for growth.

Our concern is with the management of the space that turfgrasses now occupy on earth and will occupy in the foreseeable future. No one to my knowledge has been able to keep a record of the tremendous growth of turf as a product of our time and our way of life.

All of us know how our open space (farm land, forests, coast lines) is being gobbled up by urban sprawl, new shopping centers, highways, factories, and interchanges. A large part of the space is being devoted to turf for lawns, playgrounds, golf courses, parks,cemeteries, and for protection from erosion on our highways. Now we must add the term "Beautification" for highways in the Great Society. Some of us tried to get that well underway 20 years ago.

Space on earth is finite and non-expandable. As the population continues to explode virtually unchecked, it is evident that the space available for each human being is shrinking. As more and more people use a given area of turf, it is essential that we develop the ways and means of producing turf that is capable of tolerating the increased traffic.

Twenty years ago there was no space for turf in most agricultural colleges and Experiment Stations across the land. Turf was a luxury inconsistent with space devoted to animals and farm crops. In 1945 the Midwest Regional Turf Foundation was organized. Also, in 1945 a small group of dedicated workers joined together for recognition so that in 1946 the American Society of Agronomy made space for a Turfgrass Division. Growth of Turf as an agricultural entity has advanced steadily ever since. Now nearly every Agricultural Experiment Station devotes time and space to research, teaching and extension in Turf, as do many industrial organizations.

This brings us to practical considerations of space in the micro-climate of the turf itself, and within the soil where roots grow. What can we do to provide the most effective space for turf growth? What is the best way to remove old, unwanted grass so that space is provided for the fresh, new, more disease-free growth? How can we more effectively utilize the tremendous space deep in the soil where roots of turfgrasses have failed to penetrate? These are unexplored areas of space that should challenge turfgrass scientists for years to come.

Where can we find the space to develop all our needed recreational facilities for the expanding population? What sites are most favorable for turf growth and for the people? Where is the fresh, new, uncontaminated space where we can grow in a pure condition the new superior turfgrasses that are being developed?

It is easy to ask questions, but the answers come with greater difficulty. This takes research which demands space in greenhouses, space for growth chambers, space in field trials, and space for demonstrations under actual use. Beyond this we must have space in laboratories, in classrooms and in libraries where students can learn. Finally, we must have space in lecture halls, such as this, where we learn from others. Now, I propose to vacate this space so that Dr. White can occupy it.

- - - - - - - - - - - - -

THE PARTICLES OF SOILS -- CLAYS

Dr. Joe L. White, Dept. of Agronomy
Purdue University

If one takes a chunk of soil and treats it in such a manner that it can be sliced into sections sufficiently thin to permit examination in transmitted light under a microscope, it can be seen that the soil is made up of particles cemented together by organic matter and clay arranged in such a manner that there are many openings, or pores. These pores may be small or large, depending upon the proportion of different particle sizes in the soil. The pores may or may not be connected in a continuous manner; the size and distribution of pores control the movement of liquids and vapors in the soil.

If we take a sample of well-aggregated soil, such as a Crosby silt loam, place it in a container of water and agitate vigorously, we can break down the aggregates and cause the soil to separate into individual particles. These particles range in size from coarse sand, (2.0 to very fine sand, 0.2 mm), to clay, which is less than 0.002 mm.

When we examine the various particle-size fractions with an ordinary light microscope, we can easily see the sane and silt particles, but the clay particles are too small to be resolved by the light microscope. In order to examine the nature of soil minerals in the clay fraction, the particles must be magnified thousands of times; this can be readily done by the use of the electron microscope. It can be shown, (Fig. 1) by micrographs of minerals, such as kaolinite, that minerals are well crystallized and occur as thin platelets, as laths, or as tubes.

The clay fraction is less than 0.002 millimeter in size. One millimeter is equal to 0.04 inch; thus, clay particles are less than 1/12,000 inch in size. The individual clay particles consist of hundreds or thousands of thin sheets bound together. It would require from 25,000,000 to 30,000,000 individual sheets to make a stack one inch in height. If we were to stack this many dollar bills into one pile, it would be about two miles high.

When properties such as surface area, adsorbing power, swelling, plasticity and cohesion, and heat of wetting are examined as functions of particle size, it can be readily seen that they increase very rapidly as particle size decreases. Thus, the surfaces, which surround the pore space, have properties which depend largely on the kinds and amounts of clay minerals present.

Clay minerals may be divided into two general groups: (1) swelling clays, and (2) non-swelling clays. An example of swelling clay is found in the montmorillonite group--water and cations such as potassium and calcium can move into the space between the individual sheets and force the layers apart. The kaolin group of minerals show little or no swelling. The amount of surface area exposed by swelling clays in comparison with non-swelling clays might be likened to the surface area in a book of 600 pages--all of the surface is accessible, whereas only the back and front covers and the edges are accessible if the pages are stuck together.

If your coffee cup had been filled with a rather common soil in the Midwest, Crosby silt loam, at lunch, the soil would have about 8 acres of surface area exposed in that small volume. At the wilting point, that soil would have about 5 teaspoonsful of water spread out over its 8 acres.

In addition to surface area of considerable magnitude, the clay minerals also have negative electrical charges which must be neutralized by external cations, such as potassium, calcium, magnesium, etc. The capacity to exchange positively charged ions is called cation exchange capacity and is usually stated in terms of milliequivalents per 100 grams of soil. One milliequivalent per 100 grams would be equal to 20 lbs. of hydrogen per acre furrow slice, or 780 lbs. of potassium per acre furrow slice. Values may range from 5 up to 25 milliequivalents per 100 grams for many soils in the midwest.

The clay minerals have been studied in great detail, and the general features of the structures and composition of many of the clay minerals have been well established. The silicate clay minerals consist primarily of two building blocks, namely, four oxygens at the corners of a tetrahedron usually with a silicon atom in the center, and six oxygens and/or hydroxyls at the corners of an octahedron, often with an aluminum ion at the center. (Fig. 2).

Layers of tetrahedra and octahedra may be combined in several ways, but two general groups are generally recognized. In the first, one tetrahedral layer is fused with one octahedral layer, giving a tetrahedral-octahedral layer ratio of 1:1. This group is known as the kaolinite, or 1:1 group. (Fig. 3); minerals of this group are normally non-swelling. In the second major group, the montmorillonite group, one octahedral layer is fused between two tetrahedral layers to form a mineral having a tetrahedral-octahedral layer ratio of 2:1. (Fig. 4).

Examples of this group include montmorillonite and the micas. The mica structure might be likened to two Chinese checker boards-- the marbles would represent the potassium ions. If the potassium ions in a mica were expanded until they were as large as the marbles in the Chinese checker board, the clay size mica particle would be approximately the size of a football field. As stated before, it would take 25,000,000 mica layers to make a stack 1 inch high.

As micas weather in the soil, the plates become "unglued," potassium becomes available to plants, the layers swell and permit nutrient ions, such as calcium and magnesium, and water to move between the layers. The surface area of the mineral also increases as a result of the swelling produced by the weathering processes.

In conclusion, I have attempted to briefly outline the nature, properties, and structure of the clay minerals and to point out the importance of the clay fraction in influencing the chemical and physical properties of soils.

Figure Captions

Figure 1. Electron micrograph of kaolinite (magnification 30,000X).

Figure 2. Structural units of the silicate clay minerals: A. tetrahedron and B. octahedron. Large open circles represent oxygen or hydroxyl; small closed circles represent silicon (A) and aluminum (B).

Figure 3. Geometrical model of kaolinite structure (1:1 type clay mineral) showing the manner in which tetrahedral and octahedral layers are organized.

Figure 4. Geometrical model of montmorillonite structure (2:1 type clay mineral). A potassium ion and water molecules are shown schematically in the space between adjacent plates of the mineral.

- - - - - - - - - - - - -

THE SPACE BETWEEN SOIL PARTICLES

Dr. H. Kohnke, Dept. of Agronomy,
Purdue University

As far as the plants are concerned, the space between the soil particles is more important than are the particles themselves. That is where the plants live; between the particles. The roots need water, air and nutrients, and there has to be space for them to enter. A soil microphotograph illustrates how complicated the space between the particles is. Soil is made up of particles of many sizes, but even the largest soil particle is less than a tenth of an inch in diameter. Many are so small that they cannot be seen with an optical microscope.

There are many aspects of porosity we could study. In the short time allotted let us concentrate on one item: the diameter of the pores. This varies from the tiny space between two clay particles to a mouse hole. For our purposes we can classify soil pores into four size groups. Since we are considering very small openings, we cannot use inches to describe them. Let us use microns! One-thousand microns make one millimeter, 25,400 microns make an inch.

The reason we are so interested in pore space size is that the diameter determines the degree to which the pores attract water. The smaller the pores the more they attract water. Pores larger than 60 microns in diameter quickly lose water. Air can enter soon after rain or irrigation has stopped.

Medium-sized pores with diameters between 10 and 60 microns attract water to a certain extent. Water actually is lifted several feet by "capillarity," but is drained out in a few days, if soil, containing such medium pores, is deep enough, and the excess ground water can drain away. Soil containing water in the medium pores is too wet for tillage. In a farmer's field that is not irrigated, water remains too short a time in the medium pores to be of much value to the plants. In the case of an irrigated golf green, most of the water that the plants absorb comes from the medium pores.

Small pores, those with diameters between 0.2 and 10 microns, have a great attraction for water. Gravity cannot remove this water. The small pores store the water that plants use in the farmer's field. Transpiration and evaporation are the only ways in which water is removed from small pores.

In the very small pores - smaller than 0.2 micron in diameter - water is largely held directly by the solid surfaces. The layer of water is 5 or less molecules thick (or thin). This water is held so tightly that plants cannot extract it. It can only be lost by evaporation. As a matter of fact, very dry soil actually absorbs moisture from the air.

The percentage distribution of the different sizes od pores in a soil depend on soil texture (the relative amounts of sand, silt and clay), and on soil structure (the arrangement of the individual soil particles). In a farmer's field even fine-textured soil (soil with much clay and silt) may have many large pores, because the particles are arranged in aggregates (clumps). In a golf green such aggregation is soon destroyed because of traffic when the soil is wet. Since large and medium pores are needed in a golf green soil, it is necessary to prepare it of predominantly coarse textured material (sand and fine gravel).

A glance at the table shows that placing material of exclusively large pores (pea gravel) underneath of a fine-textured soil, will result in excessive wetness in the soil because the gravel does not attract the water. Then may be best to have a soil with a high proportion of large and medium pores at the surface to avoid excess wetness.

(Table follows)

The Space Between Soil Particles

Pore size & diameter	Attraction for water	Drainage	Air and Water for plants	Root size
Large - larger than 60 microns	No attraction for water	Fast drainage, water drains out in a couple of hours	Fast infiltration and fast air supply	Equal to diameter of root tips
Medium - 10 - 60 microns	Water is attracted. "capillary" climb.	Water drains out in a couple of days	This size of pores serves best to distribute water in the soil.	
Small - 0.2 - 10 microns	Great attraction for water. Water retained against gravity	Transpiration by plants & evaporation	This is the main water supply for plants.	Size of root hairs
Surfaces	Attract even the moisture in the air. A layer of only a few molecules of water.	This water can only be lost by evaporation.	Plants cannot get this water.	

- - - - - - - - - - - - -

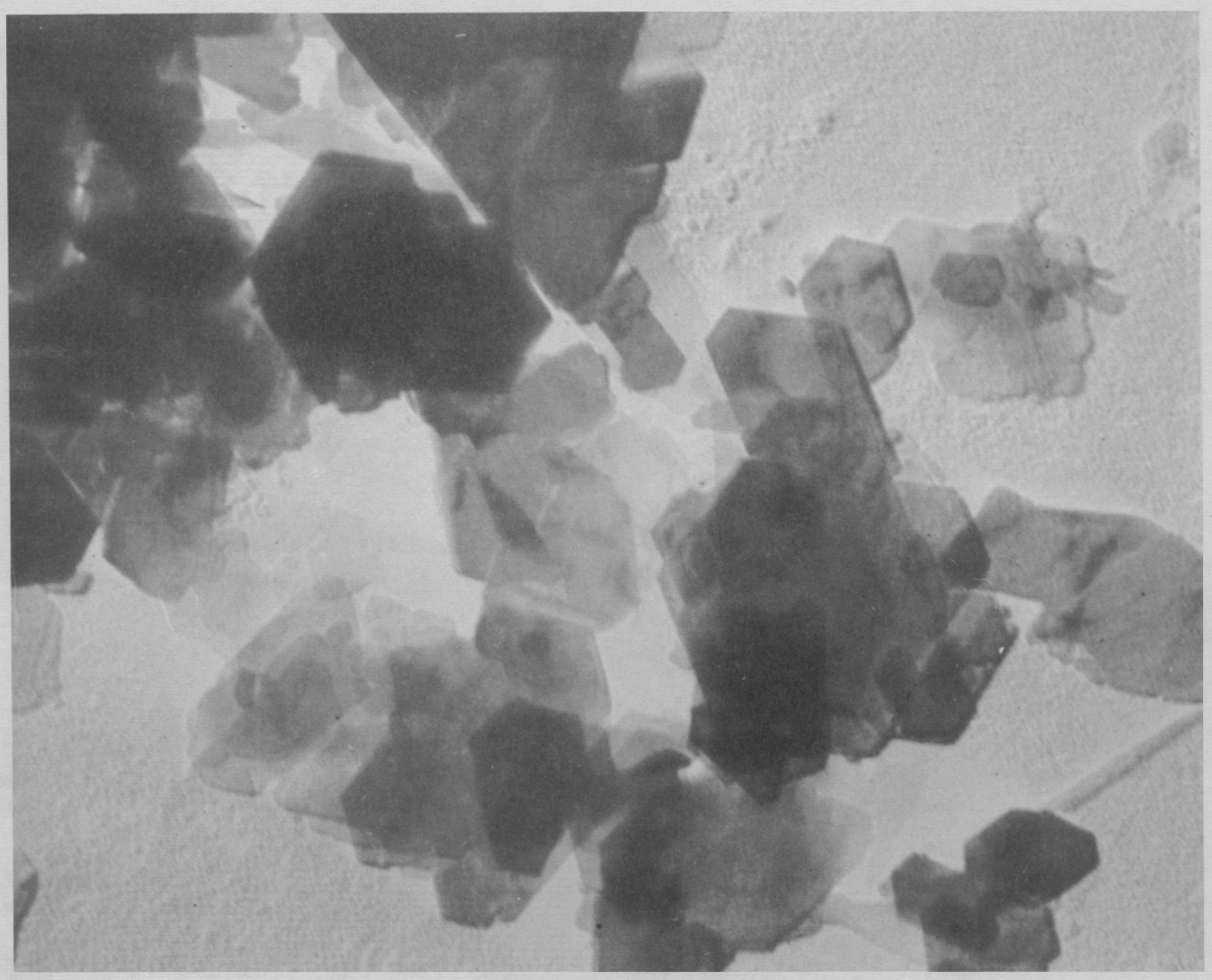


Figure 1. Electron micrograph of kaolinite (magnification 30, 000X)

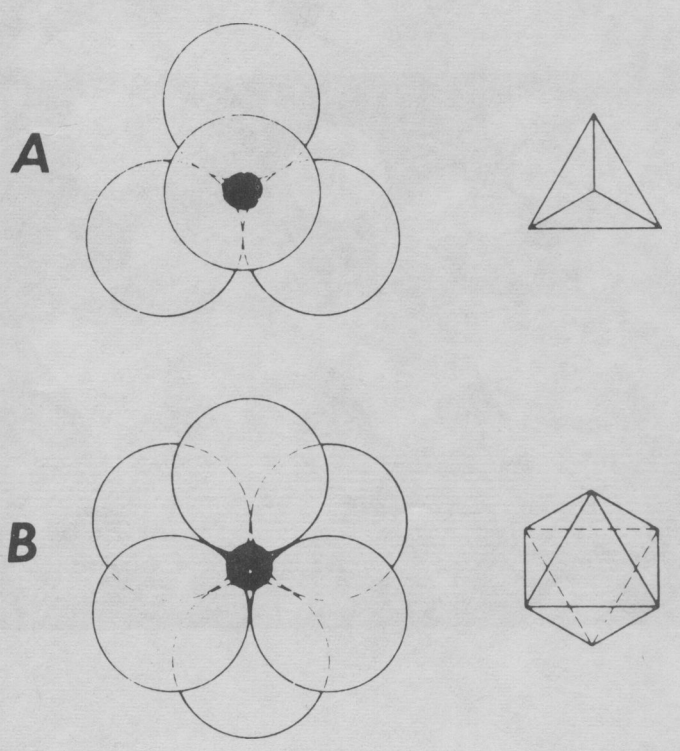


Figure 2 Structural units of the silicate clay minerals: A. tetrahedron, and B. octahedron. Large open circles represent oxygen or hydroxyl; small closed circles represent silicon (A) and aluminim (B).

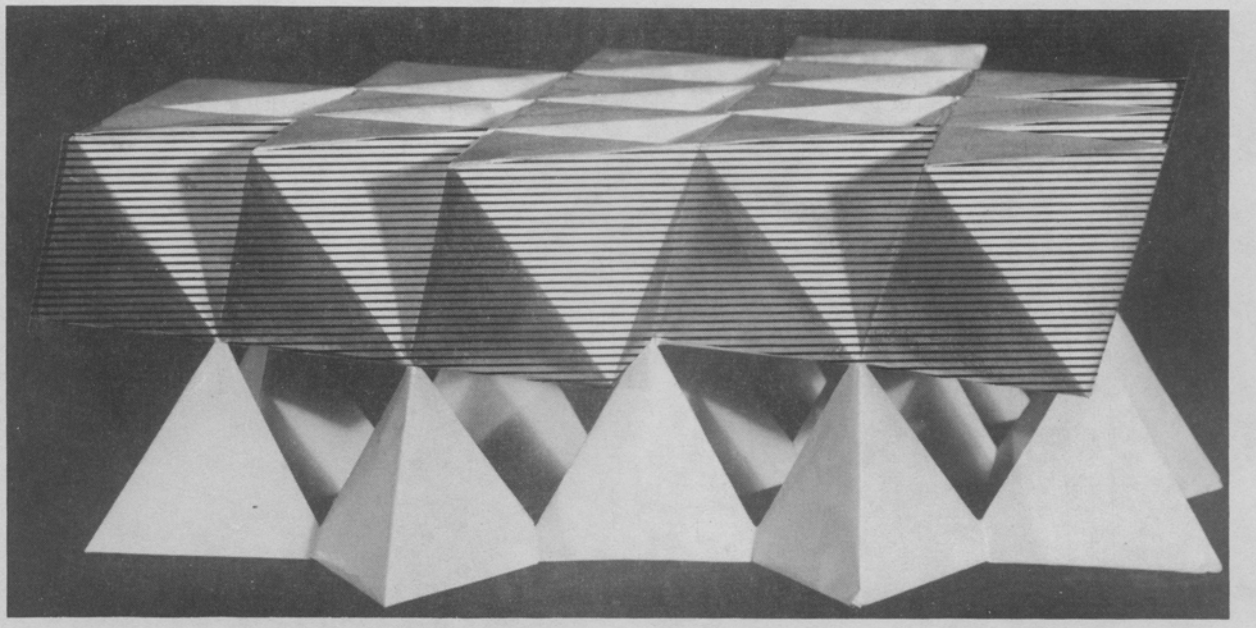


Figure 3. Geometrical model of kaolinite structure (1:1 clay mineral) showing the manner in which tetrahedral and octahedral layers are organized

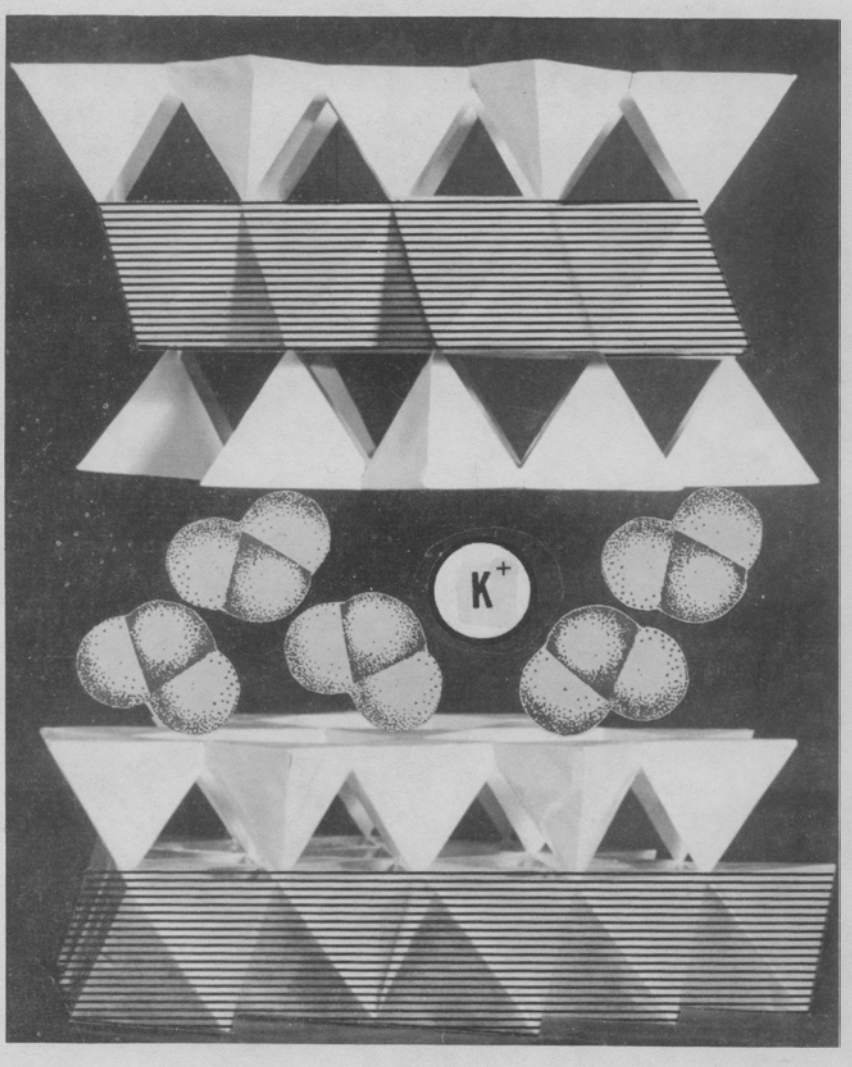


Figure 4. Geometrical model of montmorillonite structure (2:1 type clay mineral) A potassium ion and water molecules are shown schematically in the space between adjacent plates of the mineral.

INFILTRATION AND SOIL SURFACES

J. V. Mannering, Research Soil Scientist,
Soil and Water Conservation Research Division,
Agricultural Research Service, USDA,
Lafayette, Indiana

One of the more important factors affecting the entry of water into soils is the condition of the soil surface. Bare, unprotected soils are susceptible to surface sealing when exposed to high-energy rainfall. Upon drying, a soil "crust" forms which serves as a barrier to water entry, even though the soil beneath has sufficient pore space for water transmission. Soil crusts are known to have the following properties: (a) Reorientation of dispersed particles in the upper few millimeters of the surface; (b) greater bulk density than in the underlying materials; (c) less pore space than in the underlying material; and (d) higher percent of fine particles than in the underlying material. All of these properties contribute to reduced infiltration and in many areas are also the cause of poor seedling emergence.

The "rainulator" , a device for applying simulated rainfall to soils, has been used the past several years in Indiana and surrounding states to study infiltration and erosion on various soils and cultural conditions. This equipment has many of the characteristics (drop size, drop distribution, and kinetic energy) of a natural-high-energy storm that produces severe surface sealing and crusting on bare soils. The results are mostly oriented toward crop land, but the same principles apply to turf work, especially turf establishment.

There are several factors that influence surface sealing, or crust production. One of those is surface roughness. A three-year comparison of conventional tillage vs. minimum tillage for corn production near Lafayette, Indiana, resulted in vast differences in surface roughness. A micro-relief meter showed the random roughness index of the conventional (smooth) tilled soil to be 4.54 as contrasted to a value of 8.47 for the minimum tilled (rough) soil. The random roughness index is defined as the standard error among logarithms of 400 height measurements taken in 40-inch-square area. This greater surface roughness was partially responsible for a 35 percent increase in infiltration. Part of this increase resulted from less surface sealing on the rougher plot.

Another factor affecting surface sealing is soil structure. A soil recently plowed out of sod seals or crusts less readily than one plowed out of continuous row crop when exposed to intense rainfall. One measure of this difference in soil structure is soil aggregation. In a crop rotation study conducted in Illinois, soil aggregation, alone, accounted for 50 percent of the differences in infiltration attributed to treatments. As soil aggregation increased, surface sealing decreased, and infiltration increased.

Soil texture also has a significant influence on the crusting tendencies of soils. Infiltration, used as an indicator of crust strength, was found to be the highest on the coarse textured soils, and to decrease as the texture became finer until a reversal occurred starting with the silty clay loam texture. Average infiltration values for sands, loamy sands, sandy loams, loams, silt loams, silty clay loams and silty clays were, respectively, 4.6-, 3.4-, 2.4-, 2.1-, 2.1-, 2.4- and 3.0- inches. Five inches of simulated rainfall were applied over a two-hour period in this study. The medium textured soils (loams and silt loams) appear to be the most susceptible to surface sealing and crusting. One might normally expect the heaviest textured soils (clays) to be the most seriously affected. However, clay soils relatively high in organic matter are generally well aggregated and surface sealing doesn't readily occur on them. Soil properties such as organic matter, aggregation, and pore space also influence infiltration differences within textural classes.

The cultural condition of the soil at the time rainfall occurs can have an enormous influence on surface sealing. This is illustrated by the infiltration differences on three conditions tested with the rainulator. The three conditions were: (a) Growing sod approximately four inches tall; (b) a plowed, bare soil recently disked; and (c) a plowed soil recently disked with one ton per acre of straw mulch applied on the surface. After two hours of rainfall at an intensity of 2-1/2 inches per hour, the following infiltration rates were recorded: (a) Sod - 1.9 inches per hour; (b) bare soil 0.5 inches per hour; and (c) mulched soil - 1.9 inches per hour. Little or no surface sealing occurred on either the sod or mulched plot as shown by the infiltration data.

Surface cover has a tremendous influence on surface sealing and crust formation. This is illustrated by another rainulator test in which intense rainfall was applied to one plot, which was protected with a double layer of screenwire suspended about four inches above the soil surface, and to another plot that was completely void of surface protection. This study was conducted on several soil types. In all comparisions the screenwire was responsible for sizable increases in infiltration. The following results are indicative of the importance of surface cover. Infiltration increases resulting from the screen wire were 0.4-, 2.0-, 1.6-, and 1.0 inches, respectively, for an Oakville sand, Warsaw sandy loam, Cincinnati silt loam and Markland silty clay. Five inches of rainfall were applied over a two-hour period. The effect of the screen wire was to reduce drop size and velocity, and therefore, the kinetic energy of the rainfall which resulted in less surface sealing.

Still, another illustration of the effect of protective cover on infiltration and surface sealing is a study which was conducted on a soil having various rates of wheat straw mulch applied to the surface:

Mulch tons/acre	0	.25	.50	1	2	4
Coverage of surface %	0	40	60	87	97	100
Increased infiltration %	0	10	35	75	80	82
Soil loss %	100	25	10	0	0	0

The reduction in flow velocity of the runoff resulting from the barriers formed by the straw on the surface was largely responsible for the significant soil loss reductions by the lower mulch rates.

Once a soil crust has formed, it should be destroyed if increased infiltration is desired. Destruction of surface crusts by cultivation resulted in an 80 percent infiltration increase during a 3-year study recently completed. If left unprotected, continued rainfall will again product crusts on cultivated soils. Results from this same study showed infiltration to be almost twice as great on cultivated-mulch soil as on cultivated-no mulch soils. These were seasonal results in which 15 - 1/2 inches of simulated rainfall were applied with more than 80 percent of the water entering the soil on the mulched soil compared to less than 50 percent on the non-mulched soil.

In summary, infiltration is found to be greatly influenced by soil surfaces. The extent of surface sealing regulates infiltration rates in many instances. Factors that influence surface sealing include: (a) Surface roughness; (b) soil texture; (c) soil structure, and (d) the amount of protective cover. The amount of surface protection also influences the extent to which the first 3 factors affect infiltration. If a large share of the surface is covered, surface sealing will not be a serious problem.

- - - - - - - - - - - - - - - -

SOIL MOISTURE STORAGE AND DELIVERY

Dr. Dan Wiersma, Dept. of Agronomy
Purdue University

The water in the soil is in a continual dynamic state. It is constantly being removed by the plants in a process we call transpiration and replaced by rainfall, or the artificial means of irrigation. The soil serves then as a moisture reserve. The amount of water used or required by the plants is independent of soil type or texture. However, soils vary greatly in their capacities for holding water with some retaining much more than others.

There are several soil factors which influences its water-holding capacities. The principal one is texture, or particle size. In general, the finer or smaller the particle the more water is held for the plant to use. This does not hold true as the particles become very fine, such as the clays, then the total amount of water available to the plants begins to lessen.

Table 1. Ranges of Available Water-holding Capacities.

Soil Textures	Available water per foot of soil
	inches
Very coarse textures -	
very coarse sands	0.4 - 0.7
Coarse textures -	
coarse sands, fine sands & loamy sands	0.7 - 1.0
Moderately coarse textures -	
sandy loams and fine sandy loams	1.0 - 1.5
Medium textures -	
very fine sandy loams, loams & silt loams	1.5 - 2.3
Moderately fine textures -	
clay loams, silty clay loams, & sandy clay loams	1.7 - 2.5
Fine textures -	
sandy clays, silty clays, & clays	1.6 - 2.5
Organic soils -	
peats and mucks	2.0 - 3.0

The "Available water" is that between two conditions commonly called "Field capacity" and "Wilting point." Field capacity is defined as the water remaining in the soil after gravity has removed the water out of the larger pores. This is usually expressed as a per cent by weight and ranges from 7 to 30 per cent. At the "Wilting point" the plant cannot get enough water from the soil to keep it from wilting. Wilting point ranges from 2 to 15 per cent. "Field capacity" can be considered the upper limit of soil moisture, and "Wilting point" the lower limit, with the difference between the two the "Available water." These terms serve as practical reference points; however, in reality with the moisture retention properties of a soil there are not points, but is a continuous function. Further, studying these retention properties of the soil gives us insight on relation of the plant in its dynamic action of removing the water from the soil.

The plant in reality has two environments as far as its water relations is concerned. The soil,or underground environment, and the atmospheric or above ground environment. The soil serves basically as the "supply" for the water, and the atmospheric the "demand." The supply must be equal to the demand or the plant will experience a moisture deficiency and will not function properly. The water supply is

more than simply an "amount" function, but also is a "rate" and is related to the soil properties and to the plant root characteristics.

The roots of a plant may be referred to as its "plumbing" system. The deeper and more dense the roots extend into the soil, the more readily can the water be supplied to meet the plant demand. Water moves very slowly in soil, and as the soil moisture decreases the rate of movement decreases very rapidly. Thus, the plant roots should thoroughly proliferate throughout the soil to avail themselves of all available water. As the soil moisture decreases the supply becomes more limited as the moisture goes from "field capacity" to the "wilting point."

The development of the root system is an important factor as to the amount of water available and as to the efficiency which water extraction takes place. The deeper and denser the rooting, the greater the volume of water for the plant. Factors which influence the rooting include the following:

1. The genetic characteristics of the plant.
2. The internal drainage of the soil.
3. The fertility status of the soil.
4. Compaction, or layering of soils, from natural occurrence, or induced by man's manipulations.

Again, the plant must be able to attain sufficient water, through its root system, to satisfy the atmospheric demand. If the demand exceeds the supply, the plants will have a moisture deficiency and will wilt. In Table II are general evapotranspiration rates for different months and weather conditions.

Table II. Estimated Values of Daily Evapotranspiration at 40° - 44° North Latitude.

	Daily Evapotranspiration During		
	Dull Cloudy Weather	Normal Weather	Bright, hot weather
April and September	0.07	0.10	0.14
May and August	0.09	0.13	0.19
June and July	0.13	0.17	0.23

These are only general estimates. There may be occasional days with an evapotranspiration as high as 0.30 inch.

In July on a bright sunny day, 1,000 sq. ft. will require as much as 140 gals. per day. On a dull day the requirement will be about 80 gals. for 1,000 sq. ft. The soil may be able to supply the 80 gallons, but not the 140 gallons per day.

Plants in the shade, or along side buildings, will have a different irrigation requirement than those in the sun. Irrigation needs can be closely estimated by knowing the atmospheric conditions. Also, soil moisture readings, as direct measurement, are to be encouraged wherever possible.

- - - - - - - - - - - - -

TURF -- THE INTEGRATOR OF SPACE AND WATER

J. R. Watson, Director, Agronomy Division
Toro Manufacturing Corporation, Minneapolis, Minn.

To fulfill its role as integrator of space and water, turf must bring these two seemingly independent entities together, and, thereby, produce a workable and acceptable whole satisfactory to the user.

Today's basic discussions have explored many aspects of each subject. Each speaker has ably presented his topic and projected its particular role in the production of turfgrass.

We recognize turfgrass as an integrator -- a most important one -- because it brings many things, including each of us, together. We must also recognize turfgrass as a summation or an end product of a number of factors. Its role as integrator of space and water needs to be examined in this light.

Turfgrass growth in a given location is a function of the climatic conditions, soil properties and management practices to which the selected grass or grasses are subjected.

Climate exerts its influence through temperature, rainfall, wind movement and sunlight. The choice of an individual species or strain of a warm or a cool season turfgrass for a particular use is largely determined by its adaptation to climatic conditions -- especially temperature.

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 grass growth. These include support, moisture, air, nutrients and temperature. The ability of a soil to meet these requirements is dependent upon its physical, chemical and biological properties. Today's discussions have highlighted the physical properties of soils and the role porosity - the space between partices - plays in the growth and development of turfgrass.

Management embodies the choice of grass, fertilizing practices, watering practices, mowing, cultivation (aerification) and programs of disease, insect and weed control, as well as all other actions that require a decision by the turfgrass manager.

Water and Turf

Water is essential to plant growth and activity and is involved either directly or undirectly in all phases of the care and management of turfgrass. Water is necessary for germination, cellular development, tissue growth, food manufacture (photosynthesis), temperature control and resistance to pressure. It acts both as a solvent and a carrier of plant food materials -- nutrients dissolved in the soil are taken in through the roots and then carried to all parts of the grass plant in water. The food manufactured in the leaves is also distributed throughout the plant body in water.

Water transpired by the leaves serves as a temperature regulator for the plant. The amount of water within the cells of the grass leaves plays a role in counteracting the effects of traffic. When the plant cells are filled with water, they are said to be turgid, a condition that helps leaves resist traffic (foot and vehicular). Hence, adequate water within the cells helps avoid the damage which may result when pressure (traffic) is applied to grass in a state of wilting. Wilt is a condition that exists when cells do not contain enough water and are said to be flaccid. For all

these functions, very large quantities of water are required and must be readily available to the plant if turfgrass is expected to grow at an optimum.

Space and Turf

Soil, as the medium for turfgrass growth, must provide support for the plant, serve as a storehouse for nutrients, supply air (oxygen), and act as a reservoir for moisture. The texture (size of soil particle), structure (arrangement of soil particles), and porosity (percentages of soil volume not occupied by solid particles) of a soil are the basic physical factors which control the movement of water into the soil (infiltration), through the soil (percolation) and out of the soil (drainage). Texture, structure and porosity, along with organic matter content, determine the water-holding capacity and control the air-water relationships of the soil.

Texture is a most important characteristic of soils because it describes, in part, the physical qualities of soil 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 loose, porous, drouthy and low in fertility; whereas, clay soils may be hard when dry, or plastic when wet and poorly aerated, but high in moisture retention and possibly high in fertility.

Clays have a higher total porosity than sands. Clays have a large number of small pores which contribute to a high water-holding capacity and slow drainage. Sands have a small number of small pores with, therefore, a low water-holding capacity. On the other hand, the large number of large pores in sands contribute to rapid drainage. For this reason, sands will resist compaction.

Space, Roots and Water

Roots must have water and air, as well as nutrients, to grow and develop. The growing tip of the root grows through voids -- spaces -- the roots extend into new areas when conditions with respect to air, water and nutrients are favorable. Water moves into soils through the large pores and as the excess water is drained away, these pores are filled with air.

Drainage is of two types -- surface and internal. Surface drainage is accomplished through grading and contouring of surface areas. Internal drainage is a function of the physical soil properties -- aggregation of clay (structural porosity) or of sand content (textural porosity).

On most turfgrass areas, one is usually able to apply water if soil moisture becomes limiting. In too many cases removal of water at a rate commensurate with turfgrass requirements for air, does not take place. Unless soils are adequately drained, many problems associated with saturated soils, disease and compaction will arise.

Compaction squeezes or forces the soil particles together and thus reduces space. A very thin layer of compacted soil at or near the surface will materially reduce the rate of infiltration. Most of the compaction on turfgrass areas occurs within the upper two-inch layer of soil; hence, may be alleviated by cultivation (aerification).

In conclusion, healthy, vigorous turfgrass is the end product, the product that has brought many factors together; hency, turfgrass is an integrator.

ORGANIZING YOUNG WORKERS

Dudley Smith, Supt., Silver Lake C. C.,
Chicago, Illinois

When I was approached to speak on the subject, "Organizing Young Workers," I was amused. Previously, "Fertilizer Practices," "Budget Organization," and "Putting Green Construction" had been my meat. Why this topic? Why not? Labor management is undoubtedly the biggest part of my job. My crew at peak season last year numbered 24 employees. Of this group three were experienced, older men; the remaining 21 were older high school and college youths. That means that 87% of my labor force was temporary help. In some cases, each of these boys was holding down his first job. The problem was clear - either organize these lads into a working unit, or change my title from superintendent to baby-sitter.

A few years ago when I came to Silver Lake Country Club, I was amazed that the winter crew consisted of two men. I dreaded the thought of mowing 36 holes in April with one helper. However, when Easter vacation came around, several high school boys appeared and asked for their old jobs for the coming summer. The nucleus of a working crew was forming, and the impossible task was now only a challenge. Training and disciplining this green help annually is a chore. Patience was an attribute that I soon acquired. I realized that my former employers, Col. Red Reeder at West Point, and Frank Tull at Hercules C. C. must be men of iron. Now the shoe was on the other foot, and the boys were asking me for a chance.

In March I start accepting applications for summer work. At this time I try to talk to each applicant and explain the scope of the work. I stress the point that we work seven mornings each week. I limited the number of applications to about forty. Usually about ten of this number will never show up. The other boys will start in the spring, working Saturdays and evenings after school. When June 1 rolls around, I have weeded out about ten more "gold bricks", and we have a solid crew of twenty boys. I can usually depend on four or five college students returning to work also. The "high paying" construction job they anticipated never materialized. This is a benefit because I can use their experience, and make each one a crew leader to help train the new boys.

On his first assignm nt the new boy usually gets to work with Phil, my carpenter. Here he is subject to some philosophy, "No matter what job Dudley gives you, they all pay the same. Today you are in the traps, but tomorrow you might be spraying greens. Don't be jealous of the other guy - do your job."

The second person the new boy works with is Ted, my mechanic. He tells them, "We have one full-time mechanic here, that's me. I don't want any do-it-yourself amateur, or stock car jockey souping up the greenmowers. Bring your sick machine into me for surgery, but keep your damn hands off." After these two quick blows to his pride and enthusiasm, I get to the newcomer to tell him how important his job is, and how I depend on him to do his best.

First-off the tenderfoot is taught the layout of the golf course. With 45 holes to maintain, I don't want him to waste 45 minutes deciding which No. 4 hole I'm talking about. Visual aids: like the colored map on the wall, the bulletin board with its progress charts, the blackboard with its list of daily work instructions, are of endless value in orienting the new boy to his assignment.

Most of our jobs are accomplished with crews: sandtrap crew, spray rig crews, garbage run crew, rotary boys, etc. No crew ever consists of all new boys - one or

two experienced fellows are in charge. These leaders will be reprimanded if the job is unsatisfactory. Buddies from the same school, or the same subdivision don't work on the same crew,until I have observed their performance. We have too much to do in a limited time to waste any effort clowning, or goofing-off.

My biggest challenge is to instill a sense of responsibility in the boys, such as -

1. Get to work on time. I only want to give instructions once - at starting time - not every twenty minutes as stragglers show up for work. Don't play hookey on Sunday morning more than once if you want your job on Monday.

2. The value of machinery. That new greenmower you are using cost $ 435.00, and the new Professional with power steering is worth as much as your Dad's car home in the driveway. Treat our equipment with care and respect.

3. Carelessness, or willful destruction will not be tolerated. The machine will be repaired, but the cost will be charged to the offender. One sad way to learn a lesson is through your wallet, or to find that your paycheck has been docked.

4. Avoid communication with the golfers. Do your job and get out of the golfer's way. Do not mimic, or ridicule the golfers. Do not answer the golfer back with abusive language. Even if the golfer is wrong, his green fee is paying our salaries and we want him to come back next week.

5. Learn the value of the dollar. On his first job it is hard to impress on this lad that money saved for tuition and fraternity life next year is more important than a Harley Davidson right now.

There are few jobs on the golf course I can trust my boys to do and do right until they have been taught. Remember please, they possess strong young legs, vigor, and enthusiasm. Mowing greens, mowing tees and banks, rotary work, fertilizing, fungiciding, operating the chain saw, laying new water pipe, and even sodding new bent greens are some of the tasks the boys have handled well.

Likewise, there are jobs the follows can't handle:

1. All mechanical work is left for Ted. Then, no one can pass the buck about a mower scalping, or a tractor engine missing.

2. Mowing fairways is a monotonous job that I leave for an older man. He has the patience to stop and let the golfer hit his shot instead of slicing the golf ball in two. The older man doesn't think he is driving at Indianapolis either, and have the seven-gang bouncing along behind him.

3. We have two or three night watermen on duty at the same time. A boy is usually in his second or third season before he makes the water crew. The waterman must know the location of all the valves in the dark, how our watering routine is carried out, and how to react in an emergency if the pump shuts off, or a pipeline bursts. The responsibility of this job is just too great for inexperienced hands.

The wage scale at Silver Lake is based on seniority. The tenderfoot starts at $ 1.25 per hour. Then in August, before he returns to school, I award him a ten or fifteen cent an hour raise. This increase boosts his morale and encourages him to return to Silver Lake the next season. Thus, I can expect one more experienced helper. By the time the fellows are juniors in college and earning $ 1.80 per hour at Silver Lake, they are killing my labor budget.

I manage to schedule several surprises for the crew throughout the season. A few times this year, when we started at 6 A.M. and quit early to avoid the heat, there was cold watermelon at the barn before we left. Another treat is our annual trip to the Western Open. My entire crew attends the tournament on Thursday for the opening round. I want them to see Sam Snead and Jack Nicklaus, but I have an ulterior motive - I want them to observe and criticize the golf course. I want a report on how the sandtraps were manicured, etc. The outing never fails to pay dividends.

In the fall we usually have a meeting of the superintendents at Silver Lake. In 1964 we were fortunate to have the Michiana and Midwest groups visit us. The crew wanted to create a favorable impression on our guests so they came in and worked Sunday afternoon before the meeting. They policed the grounds, swept our the barns, waxed the tractors, and groomed the sandtraps after the heavy weekend play. The boys knew I would be shorthanded on Monday with most of them back in school. I certainly appreciated their efforts.

In conclusion, let me ask, "What kind of a crew do you desire?" I feel that I get more work from a high school boy for $ 1.40 per hour than I would from an older, slower man for $ 1.85. How much work can I expect from MANPOWER labor that costs me $ 1.90 an hour? After deductions the MANPOWER employee is taking home only $ 1.10. I can't blame him for taking smoke breaks and leaning on his shovel. I feel that my crew hustles for what they earn.

I am looking for boys who have an interest in golf. They might even be members of their high school golf team. Then they have a golfers outlook on course maintenance. They know how to set tee markers correctly, and what it means to set the hole cups fairly.

Working with boys, counseling them, answering their endless questions, keeps me alert and on my toes. I try to encourage some of the boys to follow a turf curriculum in college, but insist that the decision be their own. In a few weeks my 1965 crew will make its appearance. Perhaps I might train one of them to be a successful superintendent -- then all past efforts will have been worthwhile.

- - - - - - - - - - - -

INFORMING GOLFERS WHEN TROUBLES OCCUR

Ted Woehrle, Supt., Beverly Country Club
Chicago, Illinois

Since becoming a golf course superintendent some eight and a half years ago, many problems have confronted me. Some of these are small enough to handle in everyday "decision making" or management. The golfers, or members, are not informed of these relatively minor problems, which are too numerous to mention and often unimportant.

It is the BIG problem that often concerns the golfer, or member, as well as the superintendent because it usually affects the playing condition of the course. These problems fall into two categories - those that only concern your course, and those that affect the entire area, or state that your course is in. The first category, those problems that affect your own course, are the most difficult to explain to the golfer, especially if you are the only one in the area with this particular problem.

Examples of some of the problems that may only affect your course are (these are not necessarily in the order of their importance):

1. Mechanical problems involving:
   a. Equipment - improper or lack of
   b. Irrigation system - inadequate
   c. Drainage system
   d. Traffic - cart and foot
   e. Vandalism

2. Maintenance procedures, such as -
   a. Fertilizing practices
   b. Watering practices
   c. Mowing habits
   d. Spraying of pesticides

3. Nature's influence on:
   a. Disease - trees, flowers and turf
   b. Weather - rainfall (too much as well as too little), snow, sleet, ice, wind, low temperatures, high temperatures
   c. Other pests - insects - weeds, etc.

4. Management problems:
   a. Labor
   b. Budget
   c. Poor public relations

5. Just plain mistakes.

Now we come to a listing of the problems that often concern an entire area of state and these are:

1. Weather - rain, temperature, ice, snow and humidity
2. Common and uncommon plant diseases - pythium, etc.
3. Insects - grubs, Dutch elm bark beetle, 17-year locust.
4. Weeds

After placing your problem in the proper category and properly identifying the problem, we must do a little research to understand the cause of the problem. Next we ask ourselves, "What can be done, if anything, to help control this problem?" "What can we do, if anything to help prevent the reoccurrence of the problem?"

Here is a chance to put your records to work. You probably have asked yourself if these records, and all the time it takes to keep records, are worth it. In times of trouble they usually come to your aid. From your records you can determine if this problem has occurred before; if so what did you do about it. Did your remedy work? What was the date of its last occurrence? Next get your reading material out, go to the library that you have been accumulating these past years. What do you find?

If you still can't find satisfaction, then call up your neighboring superintendents and lunch with them. Discuss your problem. They, too, may be in the same predicament. Or, you could call up somebody from the other side of town and quiz him about conditions. And, for you younger superintendents, call up the so-called "Old Timers" - you will be surprised how eager they are to offer some help if they can. They may have faced this same problem sometime during their past and vast experiences.

You still have another area, or group of people to draw information from. Your state universities, USGA Agronomists, Turf Foundations, and in some cases commercial representatives will all be happy to assist you if possible.

Now, after you have gathered all the information that is available and you have decided what you are going to do, how do we inform the golfer of your problem? Here is where good Public Relations and/or Good Communications pay off. Isn't it amazing how often these two terms are popping up these days - Public Relations and Communications? Let's list a few of the better known ways used to inform the golfers of our problems:

1. Pictures
2. News releases to papers and magazines
3. News letters, or special bulletins to the Club members
4. Bulletin board
5. Become friends, or perhaps I should say better friends with the Pro and Manager
6. Word of mouth - while touring the course

The important thing is to let the golfer know that you are aware of the problem and that you will do everything possible to alleviate the condition of the problem.

If you are capable of handling the problem with your own skills and ingenuity, then by all means do it. It will be another feather in your hat. If the problem is too large for you to handle, then for heaven's sake ask for help from others. Don't be too proud to ask for help. If you do receive help - give credit to the people, or agencies that provided the assistance. If you are successful in solving the problem, spread the word to the rest of us. Brag a little and publish it.

Now I would like to show you a few slides and discuss with you how the golfers were informed of the problem and what the results were. Slides will show: flood, ice sheet damage, foot-printing on thawing greens, locust damage, ice damage to trees, pythium and several others.

Whenever possible warn the members of the possibility of future problems. This tends to get you off the hook when troubles occur. Mistakes are occasionally made by all of us. Be big enough to recognize these mistakes. If necessary the golfer should also be informed about these. Only if necessary.

Don't forget - we are still operating our courses on many theories, some of which are known to be 90% fact and others which are theories and only theories, so treat them accordingly. One of the most difficult problems to inform the golfer about is himself. Tact is a must. We cannot offend the people that pay our salaries. Remember -

1. Identify problem
2. Determine the cause of the problem
3. Solve, or control the problem
4. Prevent the problem from reoccurring
5. Warn members, if possible, of approaching problems
6. Inform members of the problem and keep them informed. Progress reports are still worth the effort and time required to present them.

- - - - - - - - - - - - - - -

UNWATERED FAIRWAYS

James W. Brandt, Supt., Danville C. C.,
Danville, Illinois

My experience on the fairways at the Danville Country Club began in March of 1953. The fairways at that time were basically a good stand of Kentucky bluegrass. Each year we had an invasion of chickweed, plantain, dandelions, and if sufficient summer rainfall fell, it brought the bountiful crop of crabgrass. Broadleaf weeds were controlled each year with 2,4-D.

You are well aware of the difficulty in mowing crabgrass. Because of the nature of growth, as the fairways were mowed, the rear roller would flip the crabgrass up, and golfers would complain that the fairways had not been mowed. Fairways were being mowed 3 times per week, starting at 1 inch and gradually raising heighth of cut to one and one-fourth inches by mid-summer.

Our first attempts at crabgrass control were purely mechanical. We would drag a section of chain link fence at high speeds over the fairways. This would actually pull some of the crabgrass, the remainder was raised or fluffed up in order that the mowers did a half way job of cutting off the stemmy growth.

In 1957 limited funds were available for fairway improvement. We had a soil analysis made. Fairways ranged in pH from 5.5 to 6.2. The soil is a thin layer of silty loam over a dense clay subsoil. Organic matter content was low, phosphorous levels very low, and potash levels adequate. Our fairways were extremely wide ranging from 60 to 100 yards in width. Fairways were cut down to an average of 42 yard width, reducing the acreage from 72 to 42 acres. In September of 1957, 600 lbs. per acre of 12-12-12 was applied in split applications. Our total budget in 1957 was $ 27,000.00 with less than $3,000.00 being spent on seed, chemicals and fertilizers. I point this out in order that you might realize what we have done must not be construed as to be the best program available, but an attempt was made to use the available funds most wisely.

In 1957 at the fall Field Day at Purdue, we saw some excellent crabgrass control using the arsenicals. Encouraged by these results, we put out 10 plots in the fairways, using 10 lbs./1,000 sq.ft. of tri-calcium arsenate 85% material. We chose calcium arsenate because of low initial cost and residual activity.

Fairways were fertilized in March using 120 lbs. in June, using 50 lbs., and again in October with 100 lbs./A of urea, giving 2.7 lbs. N/1,000 sq.ft. for the season of 1958. 1958 was an excellent year for crabgrass. The test plots of calcium arsenate came through beautifully with excellent bluegrass turf, and not a trace of crabgrass or chickweed. In late August, when crabgrass was at the height of its glory, signs were placed in the treated plots, giving the treatment and cost per acre. After seeing the results, the membership demanded that a crabgrass control program be put into effect.

In March of 1959 tri-calcium arsenate at 435 lbs. per acre was applied. This was done by running the powdered material through a farm-type spreader. The applications were split going lengthwise and crosswise of the fairway. The scatter board on the spreader was not used as the powder would build up and fall off in lumps. In April we noticed some injury to plots that had received the calcium arsenate the previous spring, the injury being confined to areas of heavy concentration directly under the portholes of the spreader. As soon as the bluegrass started to grow in the spring, the areas filled in and the turf was excellent. Playing conditions remained excellent

throughout the season. Fertilization for the year consisted of 150 lbs. on April 6, 97 lbs./A on July 29 of urea, plus 396 lbs. per acre of 12-12-12 on September 26. A total of over 3# N/1,000/yr.

Treatment for 1960 consisted of one fall application of Milorganite at 780 lbs/A. This was a year of very limited rainfall and we did not wish to use urea on a dry soil. Crabgrass in untreated areas did not survive the summer drouth. The fairways received 2 tons limestone per acre in July.

1961 was a banner year. We applied 80 lbs./A. of tri-calcium arsenate on a prepared corncob carrier in March. No fertilizer was applied in the spring as the previous fall was so dry that we thought we had an adequate carryover of fertilizer. Rainfall in the spring was adequate. We had 15 inches of rain in July. This was to be a great year for crabgrass, but not a sprig showed up in the treated fairways. These were the finest bluegrass fairways that I had ever seen.

We attempted to control leafspot on bluegrass in 1962 by using two applications of PMAS at one quart per acre in sprays on April 23 and May 3. Results were so erratic that this was discontinued. Fairways remained in very satisfactory condition throughout the season. Fairways were fertilized with 455 lbs./A of 16-8-8 in September. Crabgrass control remained excellent throughout the season, although no arsenicals were applied.

1963 was an exceptionally dry year. The sole application of fertilizer was 120 lbs./A of urea following a rain on July 12. The fairways were in very good shape for a tournament, then gradually deteriorated during the season due to lack of moisture.

1964 treatments consisted of 100 lbs./A. of Arsenate of Lead in March, 97 lbs./acre of urea in May, 200 lbs./A. of 16-8-8 on June 16 and July 16. The fairways sent through another season of prolonged drouth with no fall recovery. Tables I and II show fertilizer and arsenic applications for an 8 year period.

Table 1 - Fertilizer Treatments for 8 year period

Year	Date	Source	Rate/A	Amounts applied/1000 ft.^{2}		
				Nitrogen	Phos.	Potash
1957	9-12	10-10-10	600	1.4	1.4	1.4
1958	3-1	Urea	120	1.2	-	-
	6-22	Urea	50	0.5	-	-
	10-20	Urea	100	1.0	-	-
1959	4-6	Urea	150	1.5	-	-
	7-29	Urea	100	1.0	-	-
	9-28	12-12-12	396	1.1	1.1	1.1
1960	8-20	Milorganite	780	1.1	0.7	-
1961	10-1	Urea	240	2.5	-	-
	10-2	0-20-20	127	-	0.6	0.6
1962	9-15	16-8-8	455	1.6	0.8	0.8
1963	7-12	Urea	120	1.2	-	-
1964	5-2	Urea	100	1.0	-	-
	6-16	16-8-8	220	0.8	0.4	0.4
	7-16	16-8-8	220	0.8	0.4	0.4
	Average for 8 years			2.2	0.7	0.6

Table II. Arsenic Applications for Danville Country Club

Year	Date	Amt./A.	Source of material
1959	March	435	85% Tri-calcium arsenate
1961	March	80	85% Tri-calcium arsenate
1964	March	100	Arsenate of lead

The few following slides pictorally review our successes and failure with these treatments.

Summary and Conclusions

1. Bluegrass fairways were not good prior to crabgrass control. If sufficient moisture was present for good summer growth of bluegrass, then there was a severe infestation of crabgrass.

2. It is possible to have excellent fairways of bluegrass provided moisture and fertilization is adequate and crabgrass is controlled. This has been observed at the Danville Country Club, Champaign Country Club and the University courses at Purdue and Illinois.

3. Following the program that I have used, we had excellent fairways 2 out of 8 years; good fairways 2 out of 8 years, and poor fairways 4 out of 8 years.

4. Our chief source of nitrogen has been urea. This gives excellent results when applied to a moist soil. No urea was applied on dry soils; thus, you see a variance in time and kinds of fertilizers applied in the fall.

5. Although phosphorous content of fairway soils is low, only small amounts of phosphorous have been used in conjunction with our arsenicals for crabgrass control. These applications are made in the fall only.

6. Heavy cart traffic,when bluegrass fairways are in stress due to lack of moisture, have been an important factor in the deterioration of good bluegrass fairways. The past two seasons we have seen an invasion of knotweed in worn and compacted areas.

7. Once you have established arsenic toxicity for crabgrass, one-fourth the original amount applied on alternate years gives satisfactory control. I believe that this can be extended to every third year.

8. As a result of our experience over the past eight years, we find that 50% of the time we have fairways that are undesirable for play even though they are fertilized adequately and crabgrass is controlled.

The grounds committee, with my approval, have proposed that a fairway irrigation system be installed. A special membership meeting will be called in late spring to ascertain if the membership is agreeable to continuing the present assessment for a fairway watering system.

- - - - - - - - - - - -

MANUALLY WATERED FAIRWAYS

Tom Sams, Supt., Audubon C. C.,
Louisville, Kentucky

At Audubon Country Club in Louisville, Kentucky, 1964 was a very interesting year for us, for, you see, we went through our first year with watered fairways and we couldn't have picked a better year. More rounds of golf were played last year at Audubon than in any previous year. Cart revenue was at an all time high, guest fees were up considerably and other phases of country club operation were highly successful. Now I won't say that watered fairways were solely responsible for us having one of our better years, but it certainly helped.

When I first discussed a new and complete water system about four or five years ago with my greens committee, the biggest argument I got was - with watered fairways we will have nothing but crabgrass and without going into a sound fairway program including pre-emerge - this argument was part true. But, after a continuous series of breaks in the old system, we finally got approval to contact various contractors for designs and bids, and here is where we were really fortunate. Because we were one of the first in the Kentuckiana area to go to a complete water system, we received some very attractive proposals.

We decided on an asbestos cement and P.V.C. system, using a 4" and 6" asbestos pipe as our mains, and 3", 2½", 2" and 1½" P.V.C. As for water pressure we were very fortunate inasmuch as we had 62 lbs. city pressure combined with an approximate 76 lbs. pressure from a booster pump which gave us adequate pressure, plus adequate water volume. We used quick coupler swing joints spaced on 90 ft. centers on our fairways and pop-ups on our tees and greens.

The system was designed for a maximum use of 12 fairway sprinklers and no more than 2 sprinklers on a given fairway, but we soon found out that we could go as high as 18 sprinklers with very little loss in efficiency, and as you can see, this was a tremendous time and labor saver.

And with the pop-up system around our greens, well, I just can't say enough about it. Without using the pump we can water 9 - 10 greens at one time with a maximum of 20 minutes of watering. This compares with four to five hours of labor with the old hose-sprinkler system that we had. And, if I were asked what I liked best of our system, I would have to say it is the relative ease of syringing greens. For example, in the past, it took four to five men, syringing by hand 2 - 2½ hours to go over the course on a "hit and miss" basis, and many times antagonizing the players. Now, two men can syringe 20 greens on a normal day in 1 hour to 1 hour 15 minutes. This, plus the fact that you know that all areas on all the greens were cooled, certainly can ease your mind, especially in the hot, humid days that we in the Ohio Valley area get from June to September.

When our system was being installed, I was asked many times what type of grass I was going to on my fairways. My answer to that was that during this first year I would go along with what I had; namely, about 25% of winter-hardy, common Bermuda, and the rest a combination of Poa annua, bluegrass and bent. Our fairway mowers were set at 9/16" to favor the Bermuda, Poa and bent, and when the Poa started going out, crabgrass; and let me tell you that soft, tender and lush crabgrass isn't too bad a turf to play from. At least my members didn't mind it.

We cut fairways on the average of four times per week most of the season, mostly in the late afternoon and evening.

As for feeding, after the initial feeding in April of a complete fertilizer at the rate of 500 lbs. per acre, we followed that monthly with a light application of alternating one month straight "N" and next month with a complete, using a broadcast-type spreader, on a three-point hitch from a power take-off.

As for the type of turf I would like to have on my fairways, from the many observations I've had at Purdue and one and one-half years in my own nursery, I would say Midwest zoysia. In September of 1963, I bought 10 sq. ft. of Midwest zoysia, and after one year of planting and transplanting, I have over 1-acre for use next year. I would like to show you a few slides at this time on what I have done with Midwest. I guess you can see why I'm a little enthused with Midwest zoysia.

One observation I made last year in the Midwest zoysia nursery, we had some common Bermuda come up in the nursery with the Zoysia and from what I saw the Bermuda's rate of growth was about 20% faster than that of the Zoysia, so I think that with the water that we have available in our fairways, and the new planting methods that are available today, we should be able to grow Zoysia without too much trouble.

There were a few surprises also for us in 1964. One was the cost of water. For the months of May, June, July, August and September our bill amounted to $2496.00, or about $ 16.00 per day. When you consider that we used from 1½ million to 2 million gallons of water each week, these figures are even more surprising.

In conclusion, to the question that was asked quite often of me as to whether I would have preferred an automatic system over a manual system, such as we have, my answer is a positive "yes"; if for no other reason than having a more firm control over amounts of water on any given area.

I remember back in 1959 with my Greens Chairman and I played golf with Dr. Bill Daniel at Audubon, on November 11, Bill asked me if I thought I could maintain a better course if I had a very limited amount of rainfall, and I answered with a hesitant "yes". Well, after going through 1964, if I were asked the same question, I would have to answer with an emphatic "yes," for I firmly believe that a sound, controlled watering program ranks at the top of the ladder in establishing and maintaining the fine turfs of today.

- - - - - - - - - - - - - - -

AUTOMATIC GREENS AND TEES - MY EXPERIENCES AS A USER

Dennis McCammon, Supt., Westbrook C. C.,
Muncie, Indiana

At Westbrook Country Club our operation is based on the idea that wherever there is a particular place where a machine or any equipment can be used to speed up a job or even simplify one, it will be purchased. Therefore, at Westbrook, automation is a key word.

Constructing a new course can really be a task, especially to someone who has had no experience along this line. We began in the spring of 1962 and opened for play the first of June, 1963. Design was incorporated with construction so as to

allow for this automation and ease of maintenance. Approaches were built to allow almost complete coverage by the fairway units. Tees were built quite large, one being 80 yards long, so as to reduce injury due to intense traffic.

The water system was installed by W. E. Stephens, owner of Automatic Lawn Sprinkler Company in Indianapolis. It was the first automatic system he had put in and the problems he ran into could have made it the last.

The intake is through a 3" galvanized suction line from one of the creeks which flows through the course. Then into a 250 gal. per min. pump powered by a 20 horsepower motor. The water then goes into a 3" on the course down to 1½" around the greens and tees.

As the pipe, primarily PVC and ABS, was being laid, the electric wires for the automatic controls were put in the trench. The wires were under the pipe in all cases, so if digging the line up became necessary, the risk of cutting the wire would not be as great as if they were on top. The wires cross our bridges enclosed in conduit. The pipe system is a loop-type due to the layout of the course. This was the only plan that could have worked out satisfactorily.

The automatic part of this system is based on two clocks in the pump-house; one for greens and one for tees. These enable me to setthe length of time for the water to be on any green or greens, at any time or as many times during the day as needed. This also holds true for the tees as well.

The clocks also allow the system to be operated from the pump-house manually as well, for occasional syringing when play permits, frost removal on low greens, line checking, etc. When the system is on automatic, the pump first comes on, building up a maximum of 125# and operating at 95 - 100#. The cycle is then repeated until the greens are done. The tees then come on, and when they finish the sprinklers and pump all shut down, ready for the next cycle.

Out on the course, the water really flows. On the greens, No. 41 Rainbird impulse pop-ups are used, usually 3 to a green, but on two of the larger ones, 4 heads are used. Nozzle sizes are standard, 7/32 and 11/64. The only problem arising with the placement is what I call the "overlap miss" outside of some green. Engineers and experts all call it some other name, but this is what it amounts to - it is the area where the sprinklers cannot water, where their spray pattern arcs miss each other. However, this can be supplemented by the old hose and sprinkler standby when it gets too dry.

The tees have Rainbird roto pop-ups which give fair coverage, but when the weather gets really dry, the bad pattern really shows up. Larger sprinklers should have been used and on a few of the larger tees they were utilized.

Out on the course each green and tee can be operated by hand at each electric valve. Actuation is made by opening a petcock on the end of a plastic tube which is attached to the valve. Opening this relieves down pressure on the valve cup, allowing the water to pass and enter the sprinklers. There is also a snap valve outside this manual control so that any time the automatic system at the green or tee is inoperable, a hose and sprinkler can be supplemented.

The valves were buried about two feet below the ground under inverted five gallon cans. Four inch holes were cut in the center of the bottoms and a piece of Orangeburg pipe running to the surface was inserted in the hole. This allows access to the valve and the plastic tube.

The system is drained by means of french and manual line drains situated along the various low places in the line.

The main advantage of this system is quite obvious - it eliminates one man entirely from the payroll. This in itself is a big selling point when presenting this to your board. As to the ease of operation, it has a lot of variation on the course. I am still learning the water requirements of some of my greens, and with this leaching, there is opportunity to over or under-water the greens. All in all, to set a clock and push a switch is a lot easier than pulling a 100 foot length of hose around a green at 3:30 in the morning, listening to the dogs howl at the moon and tripping over people in the dark.

There are no "disadvantages" as such to this type of system, but there are problems which do arise on occasion. During clubhouse construction electricity was off for about 11 hours, causing the clocks to come on at 2:00 on Saturday afternoon while my wife and I were gone into town.

However, the main problem we have encountered is with the suction intake on the stream. Weeds, trash and leaves collect on the screen over the foot valve. We will probably remedy this this summer by installing precast octagonal concrete tile, one inside the other. These tile have holes in them and pea gravel between them. With the intake in the center, the water is filtered by the time it seeps into this area. Several of these have been installed and have all proven quite satisfactory.

One thing to keep in mind is that when this type of pipe is used, heavy machinery must be kept off. Normal maintenance equipment is not heavy enough to cause damage, but when we were paving the parking lot, the weight from packers and trucks split one piece its entire length under the paving.

As to cost, the entire system at Westbrook ran in the neighborhood of $46,000, including time, materials and equipment. This included repairs to the three ditchers that were practically destroyed digging in our rock garden during the first few hours of ditching. By and large, however, this water system has proven itself to me and has been well worth the cost. This seems to me to be the only satisfactory solution on today's modern courses where play necessitates the modernization of all possible.

- - - - - - - - - - - - - - -

A MODERN WATERING SYSTEM FOR YOUR GOLF COURSE

Ed Shoemaker, Rainy Sprinkler Sales
Peoria, Illinois

The technique of applying water mechanically has greatly improved during the last few years, but we still have much to learn about the agronomic aspect of watering turfgrass. However, we have a fairly good understanding of the basic soil-water-plant relationships and have developed workable manual systems of adding water to this complex, which can promote good grass growth. As we begin to use the more sophisticated automatic systems, we have much better control over how much water we apply and how often we apply it. This better control gives us much more flexibility and will enable us to learn a lot more about how much and when we should apply water to turfgrass.

This discussion will be primarily concerned with the types of sprinkler systems that are available for your use today. The exact technique of how much and when to water your golf course is something that I can't tell you and that you won't be able to get from any reference book. You can study the basic principles of watering, then you will have to apply them to your particular conditions. As you so well know, conditions not only vary greatly from one course to another, but they even vary greatly from one green to another on the same course.

There are basically 4 mechanical methods of watering greens that are used in the Midwest:

1. Hose and sprinkler.
2. Sod cup over valve.
3. Perimeter quick coupling multiple valves.
4. Perimeter rotor pop-ups.

For many years the most popular method has been the portable hose sprinkler method. Normally, one or two quick coupling valves are located at the edge of the green and at least 50' of hose is required in addition to a portable sprinkler. This method requires the lowest initial capital investment, but it is subject to fairly high annual maintenance cost in replacement of hose and portable sprinklers. This method requires the greatest amount of labor, and skill is required in determining the proper placement of the sprinkler and how long to leave it in each area.

This sod cup method is primarily a Chicago area practice, but has been used very successfully in that area. This method utilizes a quick coupling valve buried in the center of the green. This valve is protected by a heavy brass casing with a cup of sod located in the top of the casing. The cup is removed and a sprinkler is inserted for the sprinkling of the green. For both the portable hose method and the sod cup method, the selection and proper adjustment of the sprinkler is very important. When only one setting is to be made in the center of the green, it is important to have a sprinkler that will give uniform distribution from this single setting. For several years conventional 2-nozzle sprinklers were used and they deposited too much water in the center of the greens. Newer sprinklers are now available that can do a good job with a single center of the green setting.

A third method that was gaining a lot of favor until the last three or four years, was the perimeter quick coupling valve system. Quick coupling valves are spaced at regular intervals around the perimeter of the green and sprinklers are inserted directly into the valves. This method eliminates the hose used in the portable sprinkler method and waters a much larger area than the sod cup method.

I would estimate that 80 to 90% of all the new systems that are now being installed are going in with rotor pop-ups around the perimeter of the greens. With proper spacing and pressure this method can give you the most uniform coverage of the greens and also will cover the important collar and approach areas. These rotor pop-ups can be operated by a manual valve, or an automatic remote control valve. In addition to regular watering, syringing or cooling of the greens is quick and easy with the rotor pop-up system.

The design of a fairway watering system for the Midwest changed very little for many years, until the last three or four years. The conventional system has been a manual system using quick, coupling valves at regular intervals down the center of the fairway. Sprinklers that would cover from 150' to 200' diameter have been inserted directly into the valves and moved at regular intervals down the fairway. This sytem normally requires that the sprinklers be moved three times per night and usually five nights of watering are required to cover the entire golf course.

Three years ago there were no automatic golf course watering systems within a 250 mile radius of Purdue University that I knew of. Today, there are at least nine completely automatic systems and at least eight more that have automatic tee and green systems. This indicates that automation is moving into the Midwest at a fairly rapid pace. Most of the automatic fairway systems in the Midwest to date have been single row systems. Large diameter of coverage, rotor pop-up heads, with a remote control valve under each head, are placed at regular intervals down the center of the fairways. All of the Midwest systems to date are electric systems as opposed to the hydraulic systems being used in the non-freezing climates of the south and west.

In some areas two rows of smaller diameter of coverage sprinklers are being used down each fairway. This increases the cost of the system over the single row system, but has the advantage of requiring a lower operating pressure. In the more arid areas, some 3-row systems are being used where wide fairways are desired. Full coverage systems that cover all the rough in addition to tees, greens and fairways, are becoming common in the western part of the U. S. A full coverage system was installed this last fall at Echo Woods Country Club at Commerce, Michigan near Detroit. It will be in operation in a few months.

With automation you now have a choice of a single row system, double row system, triple row system, or a full coverage system. Your system should be designed by someone who is up to date on the newest methods and someone who has had much experience in this field. Be sure you aren't getting a 1940 type system when your course has 1965 needs.

In addition to the types of coverage available, there are many other important considerations in the selection and design of a sprinkler system. The pumping plant, the heart of the system, needs very careful selection and planning. Selection of the contractor to install the system could be the single, most important decision that you have to make in getting a good, modern irrigation system.

- - - - - - - - - - - - - - -

ECONOMICAL AUTOMATIC LAWN WATERING SYSTEMS

J. R. Watson, Director, Agronomy Division,
Toro Manufacturing Corporation, Minneapolis, Minnesota

The role of water in turfgrass growth and development is well known and has been discussed on many occasions. Water is essential for satisfactory and successful turfgrass production. It is necessary for germination, for cellular development, for tissue growth, for food manufacture and for temperature regulation. It is a solvent and carrier of plant food materials.

The amount of supplemental water required to keep lawns green and healthy throughout the growing season is dependent on several factors -- the most important being temperature, sunlight, wind movement, and, of course, rainfall. Based on average weather data for the Midwest over a 30-year period, it has been calculated that supplemental water will have to be applied in varying amounts for four to five months to sustain growth and keep grass green during the growing season. July is the month requiring the most supplemental water.

Techniques and devices available for applying water to the home lawn are flooding, subsurface watering and sprinkling. Flooding and subsurface irrigation are rather

inefficient from the standpoint of water distribution and use. The practices are not very widespread.

Hose end devices and underground sprinkling systems are the means by which lawns are usually sprinkled. Of these two methods, hose end devices are, by far, the most generally used. Hose end sprinklers are available in many sizes, types and prices. Such sprinklers often deliver water at rates faster than the soil can absorb -- often at cloud-burst intensity (one or more inches per hour). Under such conditions they need to be moved frequently; and since this must be done manually, there is a tendency to over-water and to waste water -- because of runoff.

Underground sprinkler systems are pre-planned for complete coverage of the lawn. Such systems use tailored sprinkler heads, selected precipitation rates for the exact needs of the grass, shrubs and flowers, and underground piping with sprinklers attached at pre-determined locations. These systems may be manually controlled by a hand valve or automatically controlled by a master clock.

Conventional underground sprinkler systems reduce the amount of hand work in watering, but do not necessarily improve the efficiency of water use, or reduce wastage. If conventional systems are not pre-engineered, then they are merely a do-it-yourself version of underground pipe with sprinklers either sticking up through the ground for above ground sprinkling, or a series of small sprinklers mounted flush with the ground.

Conventional undergound systems generally use many small sprinkler heads and a great deal of pipe. When installed in an established lawn, there is considerable disturbance or "tear up" of the turf. In most cases, the services of a plumber and electrician are needed to hook the system up to the water supply and the controller to electricity. Such systems require good pressure -- greater than the average house supply for best operation. Also, they require careful draining in the winter.

In most conventional systems the heads are matched to the water supply and laid out in a circle-type pattern. They must be carefully overlapped to attain complete and uniform coverage. Frequently they apply too much water and at too fast a rate. No one manufacturer makes a complete set of components for conventional sprinkler systems and usually an assortment of manufactured products must be matched together in order to complete a system. The conventional system requires rather careful engineering to be completely satisfactory.

Increased automatic control use now offers much to homeowners. The economical, automatic, underground lawn watering system, which is the subject of this presentation, represents a new development by Toro Manufacturing Corporation. This sytem has been simplified through careful factory pre-engineering, i.e., components are completely pre-matched to work together under a large variety of conditions. Installation is relatively simple and instructions are printed in a manual. Only one size pipe and two types of sprinklers are needed. A Wave Sprinkler for large areas, and small pop-up sprinklers for harder to reach areas, are included in the package. Both types may be adjusted to sprinkle different shapes and sizes of areas. A standard electrical hook-up completes the system. Other features of this new simplified approach to lawn watering include simplicity of hook-up to hose faucet -- no complicated plumbing is required -- yet it is designed to meet national sanitation codes.

The system operates on low water pressure and water supply. This, along with fewer parts and ease of installation, make the system adaptable to the average home lawn -- at a price comparable to other popular appliances.

The Toro system is fully automatic. It utilizes a clock controller which may be set once (as a clock radio) and then forgotten by the homeowner. The clock con-

troller may be programmed for light waterings up to five times per day, or may be set for heavier waterings once every other day. Programming the clock to suit soil and terrain features will result in more efficient watering for a healthier turf at reduced water costs. The precipitation rate is as low as .2 of an inch per hour - about as fast as the soil will absorb. In addition, the clock permits the system to operate unattended at periods when water pressure is not affected by other uses.

Caution should be exercised when dirty lake water, or sandy well water constitutes the source of supply. Filt rs that will help in these situations are available and should be used if needed.

The Wave Sprinkler pattern will be affected by wind; however, the clock permits sprinkling at times when winds are at a minimum. Also, the system will run when the homeowner is away on vacation -- this may be a disadvantage in the event of rainfall. Although the pre-engineered package is designed for lawns of approximately 8,500 sq.ft., the use of several packages allows simplified installations as large as 30,000 sq.ft. Lawns over this size will usually require some custom designing.

A movie illustrating this system, its packaging, design and installation was shown and is available through orders.

- - - - - - - - - - - - - - -

LAWN WATERING SYSTEMS
SALES AND EXPERIENCES

A. E. Robison, Pres., A. E. Robison Company
Kansas City, Missouri

To discuss Sales and Experiences in regard to Lawn Watering Systems, the greatest sales getter is the beautiful lawn the neighbor has with his watering system. It also means he has to use fertilizers, seed and good maintenance. When the neighbor sees their results he becomes a real prospect for a sprinkler system. Another great sales help is the recommendation that the sprinkler system owner gives as to his satisfactory dealing with the installer and the service the installer has given on his system. Service is the one thing where so many installers fail. We give one season's free service as part of the installation, plus prompt and reasonable priced service after the contract guarantee.

A good contract should be used on installations that are fair to both parties. We do not furnish a plan and specifications on home installations before signing the contractual agreement, as we spell out in the contract that a given area will be covered evenly and efficiently with a certain make and size of sprinkler head and kind of pipe and fittings to be used. If plans and specifications are desired, there is a charge for measuring, laying-out and drawing these plans and specifications so the owner can submit these for bids.

As to other sales aids the postcard with pictures of lawn sprinkler system is excellent to be mailed to purchasers of new houses, builders, and etc. Newspaper advertising, mainly local community papers, radio and better homes shows. Yellow pages of the telephone directory are a good advertising aid. Keeping close relations with landscape architects, nurseries and lawn service people is good.

After 35 years and approximately 5000 home, commercial and golf course installations, I'm amazed at the advancement and improvement of sprinkling devices. Especially in the last ten years, hydraulic and electric operated valves and moisture-sensing devices for turf sprinkler systems are tremendous labor and water saving devices. Automation on turf and agriculture systems will pay for itself in two to five seasons.

Mr. Van Thompson had an exhibit of lawn sprinklers at the 1933 World's Fair in Chicago. Mainly they displayed small stationary lawn and shrub sprinkler heads. In about 1936 the hydraulic valves and electric clocks controlling solenoid valves that actuated the hydraulic valves came into first use. Electric valves with solenoid made as part of the valves again came into use about ten years ago.

Commercial automoist sensing units were first used about 8 years ago with about 700 of them in service in the Midwest area. The turf and agriculture irrigation industry has a tremendous future.

- - - - - - - - - - - - - - -

AUTOMATIC SENSING CONTROLLERS FOR AGRICULTURE AND TURF WATERING

A. E. Robison, Pres., A. E. Robison Company
Kansas City, Missouri

The Automoist Automatic Controller is a patented, soil-sensing unit, which may be attached to any Electric Controller. This Controller will operate only when the soil dries to the desired amount of moisture that the owner wishes to maintain, set the 24 hour dial to the time of day that water is desired, but it will not operate until soil moisture is dry to the point desired and set on soil-sensing dial. This is similar to setting thermostat for heat. Through an adjustable resistance unit, the soil moisture can be maintained from a range of dry, or approximately 25% moisture content, to 100% completely saturated.

The advantages of a sensing unit over a straight electric 24 hr. dial controller with which desired amount of water applied is based on number of minutes set for the system to run, which has to be determined by guess on the part of the operator are:

1. Eliminates this guesswork by operator, as system will run until moisture saturates to moisture probe which is buried approximately 1/2 inch to 3 inches, depending on the soil and type of grass.

2. System will not operate again until soil drys to desired level wanted (depending on natural moisture received, soil types and humidity). Spring and fall of year in the Midwest may be 3 to 4 week periods between waterings.

3. Storm probe located on roof of property, or out in an open area, will not let the system operate when mist or rain is falling and until storm probe dries.

4. Turfed area will be watered properly without any attendant to turn on and off. People on vacations will have their turf watered all the time they are away. Commercial properties will be watered at off-business hours to correct amount without human element of guesswork.

5. Sloping terraces and fairways can be watered by several short period applications, recycling three or four times, giving moisture a chance to soak in, eliminating runoff.

6. Savings of water and labor will usually pay for adding sensing-unit in from two to three seasons.

7. Most manually operated sprinkler systems the tendency is to over-water, especially lawns and commercial properties, forgetting after turning on and not knowing how much water is needed.

8. Automatic Controllers and sensing units are really just beginning to come into more usage due to more efficient use and saving of water and labor both for turf and agriculture irrigation.

University of Nebraska has started agriculture pump by remote control from soil moisture sensing units the last five years.

There are many uses for automatic controls besides turf area, such as frost control, plant cooling, and even dust control around buildings as is being used now in Southwest Kansas and New Mexico. Automation is just in its infancy. The next five to ten years will see a universal use of these improvements.

- - - - - - - - - - - - - - - -

IRRIGATION INSTALLATION, MINIMUM STANDARDS

(As prepared by Sprinkler Irrigation Association)

Index of items to be covered in Installation specification: (Design and materials not covered by this spec.)

These were discussed by John Oldfield of Oldfield Equipment Compnay, Cincinnati, Ohio. He has put in approximately 10 watering systems recently.

General

1. Scope of work.
2. Time limits for completion. Working days. Weather?
3. Shop drawings. Mfg. sprinkler drawings - Mfg. Spec. Sheets
4. Bonds, to be paid by owner.
5. Codes and Permits. Contractor permits & codes

6. List of Plans and Contract Documents.
7. Protection of Utilities and other work - Trees and shrubbery, drain tile
   Owner to stake out
8. Insurance - Liability and Property Damage - Workmens Compensation
9. Substitution of material - Equal quality only upon approval by owner.
10. Water Source - On contract.

11. Errors in Drawings and Design - Corrections to be negotiated.
12. Supervision by Contractor and Employees
13. Sub Contracting
14. Payments, Partial and Final
15. Claims for Extra Work - Authorized by Owner's Agent

16. Progress of Work
17. Overtime work - authorized by owner's agent.
18. Layout of Work. Where necessary owner's agent to assist and approve layout.
19. Working Area - supplies and storage.

Specifications

20. Pipe Installation (covering various types, depth, handling of pipe, making of joints, horizontal clearance, storage)

21. Excavating (covering rock, wet conditions, shoring and bracing, width, over-excavation, etc.)
Closing area of work from other activities.
Rock and other unforeseen obstructions.
Notify agent, negotiate.

22. Drainage (covering drain valves, boxes, sumps, etc.)
23. Sod lifting and replacing - Whose responsibility?
24. Backfill (covering compaction, type of material, frost, unforeseen conditions)
25. Corrosion?

26. Clean-up of area. Erosion and weather damage.
27. Concrete and asphalt repair - Responsibility.
28. Sprinkler Installation (covering type of joint, height of sprinklers, lowering to grade).
29. Loose equipment to be furnished (sprinkling equipment and valve keys). Consideration of owner's equipment.
30. Valve installation.

31. Automatic valve installation.
32. Control wire or control tube installation (covering, splicing and fitting).
33. Automatic controller - stands - mountings.
34. Pump type installation.
35. Pump Start-up and Che[illegible]-out. - Responsibility.

36. Electrical wiring and controls.
37. Testing and flushing
38. Adjusting of System - Minor by owner.
39. Instruction to owner.
40. Make record drawings - As built, including drains.

41. Owner's acceptance.
42. Guarantee (Procedures and time limts).
43. Owner's responsibility for maintenance.

- - - - - - - - - - - - - - - -

HOLDING POA ANNUA FAIRWAYS

Donald Likes, Supt., Hyde Park Golf & Country Club
Cincinnati, Ohio

Cincinnati, like several other cities, is located in the transition zone. That "inbetween zone," too far south for Northern grasses, and too far north for Southern grasses. It's just right for crabgrass, goosegrass, clover, Poa annua, and everything that a golf course superintendent doesn't want to be associated with.

Hyde Park Country Club is located in a bad zone, within a bad zone. We are at one of the lower elevations, with a large hill blocking the prevailing summer winds. We have many large trees, presenting a definite shade problem on greens, tees, and even parts of fairways. Along with this, we have a wet clay soil.

Over the years we have tried different grasses with no satisfactory results. First, bluegrass didn't have a chance. Our players insisted on a close-cut, watered fairway. We have, in our area, several satisfactory Meyer zoysia lawns. We tried at least three different methods of planting our fairways to Zoysia at different times of the year. Each time we succeeded in getting it established, but each time it failed to compete with Poa under our requirements of maintenance; namely, a close cut, green watered "turf."

Next we tried Astoria bent. A renovation program of burning existing vegetation with sodium arsenite, aerifying, and seeding was tried. A good stand of Astoria bent was established in the fall. The next season it still looked good, although some Poa had come in. In July, during a bad spell of weather, the Astoria was damaged severely, and the result was such that when the turf recovered it was predominently Poa Annua. We observed that the creeping types of bent were the only surviving bentgrasses.

We would like to point out at this time that, although our procedures, which we are about to disclose, have been somewhat successful, this does not mean that it would be so at another location. We have unusual conditions at our club; each golf course is different with many factors involved. If you are having success with a certain fairway grass, stay with it and try to improve upon it.

As we stated above, the creeping bents were the only surviving types of bentgrass from our previous renovation programs. In the fall of 1961 we overseeded our fairways with Seaside bent. The existing turf was not burned off, but merely aerified and cut with a disk. A good stand of Seaside was established in the disk pattern; the rest being about 50% Poa annua.

Our procedure during the 1962 season was to use PMAS and iron sulfate sprayed periodically to encourage the creeping type bents. We also decided to start our fairway water program before the Poa started to burn out. This being a new procedure for us. To our surprise, we were able to hold the Poa through the entire season. We feel our success in holding Poa was due primarily to the application of fungicide and the added attention with our water system. We feel that dollarspot and iron chlorosis are the big factors in the loss of Poa annua. A healthy Poa, like everything else, has a much better chance to survive adverse weather conditions. We sprayed every 10 to 15 days at the rate of 1 qt. PMAS and 4 lbs. iron sulfate per acre. We used both major brands of PMAS with the same results; however, we found a big difference in brands of iron sulfate. We had best response with U. S. Steel "sugar of iron" delivered in a 400 lb. paper drum. We got absolutely no response from an iron sulfate purchased from a fertilizer company in 80 lb. bags.

As for our program, we have had good response with 16-8-8. Our program is:

	Lbs./acre	Actual N	P_2O_5	K_2O	
Early spring	300	48	24	24	
Late spring	200	32	16	16	
Early fall	200	32	16	16	
Late fall	300	48	24	24	
		160	80	80	per 1000 sq.ft.
		4	2	2	

This must be applied only with a roto-whirl type spreader, and if the weather is hot, the sprinklers must go on immediately, or no later than the same evening. We have had good response with Armour's 16-8-8 and practically no response when we switched to another brand of 16-8-8. This, too, could work just in reverse at some other location. One thing we feel is important, and that is that the source of nitrogen be mostly from sulfate of ammonia. We can't give you a good reason other than it is an old-time grass grower.

As we said before, a fair turf of Poa held very well through the 1962 season. In 1963 an improved turf of Poa again held almost 100% through the season. By early 1964 we had an excellent turf of predominantly Poa and a small percentage of bent. This was a very difficult season with adverse weather conditions. However, our Poa fairways survived with only about 5% loss.

To summarize, we feel that the use of a fungicide is a must. Poa must be disease free to survive the hot weather. Water management must be precise. It is very obvious where the water man neglected the turf. Poa is lost and goosegrass takes over. We don't recommend that you try to hold Poa fairways. The chances are, your conditions are much different than ours. However, if you are in a location of poor air movement, with many shaded areas, and you have had difficulty growing other grasses, you might try holding Poa fairways. If you do, be prepared for a real careful battle in July and August.

- - - - - - - - - - - - - - - -

FAIRWAY IMPROVEMENT - SECOND REPORT

Norman Kramer, Supt., Point O'Woods C. C.,
Benton Harbor, Michigan

I would like to begin this year by giving you a brief outline of what we did to our fairways during 1964, on January 29 with applying 2000 lbs. dolament lime per acre on frozen soil. On March 23 I called three men of the summer crew back to work to start cleaning up the fairways, and on April 15 the fairways were cut for the first time, and three or four times thereafter as needed. All dew is removed from fairways and tees whenever there is a noticeable amount on the grass in the morning by dragging hose behind tractors. We fertilized fairways for the first time on April 17 with 250 lbs. of 12-6-6 per acre. During the season we sprayed fairways with iron 6 times; with PMA 7 times, and Thiram 6 times.

Date	Per/1000 sq.ft.
June 23	2 oz. Zineb 2 oz. PMA 3 oz. Iron sulphate
June 29	2 oz. Dyrene 1 oz. PMA 1 oz. Thiram 2 oz. Zineb ½ lb. Urea 45%
July 3	1 oz. PMA 3 oz. Dyrene 1 oz. Thiram 2 oz. Iron sulphate
July 16	1 oz. PMA 4 oz. Thiram 1 oz. Iron sulphate 2 oz. Minerals (ES-Min-El)
July 21	1 oz. PMA 2 oz. Iron sulphate 5 oz. Thiram ½ lb. Urea 45%
July 31	1 oz. PMA 4 oz. Urea 45% 1 oz. Iron sulphate 1½ oz. Dyrene 1½ oz. Thiram
Aug. 4	1 oz. PMA 3½ " Zineb 1 oz. Thiram 1½ " Iron sulphate

On August 17, Monday, the major part of our improvement program began. We aero-bladed tees, seeded with Seaside bent, dragmated, swept, and watered all the tees on the course. Also, we aerified all fairways, using 1/2" thatch spoons. The next day we started aero-blading fairways, using the same process here as we did on the tees of aero-blading, seeding with 80% Seaside and 20% Penncross at the rate of 20 lbs. per acre (note the 20% Penncross - since it is a very vigorous grass we felt we would give it a try). We continued to dragmat, sweep and water through August 20 until all fairways were completed. Germination was excellent. On Monday, August 24, we fertilized fairways with 20-10-5 at the rate of 120 lbs. per acre. This played a big part in helping the young grass do so well.

It was now time to put in motion a program which I had set up on the greens and tees - the program of trying to overcome the consistent inroads of Poa annua in the fairways. This meant applying calcium arsenate at the rate of 5 lbs. per 1,000 sq.ft. spring and fall, as early as is possible both in the spring and fall. This was done on a trial basis on #5, #6, #7, #8 and #15 fairways. May I add right here to make certain your board and club members know what you are doing, and why; otherwise, you may be looking at browner pastures! This is where I slipped up. After applying the calcium and it was obvious the results were going to be very good, the phone began to ring and I don't have to tell you what some of my members said!! Believe me when I say I did not waste any time in getting a letter off to the entire membership with the most gratifying results.

The Poa annua was gone - now what next? I decided to reseed on Tuesday, September 15. I used the same process as in the past with excellent results and very good germination. On Wednesday, September 16, the fairways were fertilized with 100 lbs. of 45% Urea to the acre. This would be the last fertilizing for the fairways except #5, #6, #7, #8 and #15, which were given a light application of 20-10-5 on October 12, along with a light seeding broadcast over the area. This concluded our program for 1964.

Date	Material	Lbs./A.	Actual N	-	P_2O_5	-	K_2O
April 17	12-6-6	250	30	-	15	-	15
May 25	12-6-6	250	30	-	15	-	15
June 6	45-0-0	90	40	-	0	-	0
July 17	45-0-0	10	4	-	0	-	0
Aug. 24	20-10-5	120	24	-	12	-	6
Sept. 16	45-0-0	100	45	-	0	-	0
			153	-	42	-	36
		per 1,000 sq. ft.	4	-	1	-	1

What are the plans for 1965? First, calcium arsenate as early as possible; second, more aerifying with 1/2 inch coring spoons, and, last but not least, I pray for help from the man above.

- - - - - - - - - - - - - - -

DEVELOPING BLUEGRASS FAIRWAYS - MY PROGRAM

Don Clemans, Supt., Norwood Hills C.C.,
St. Louis, Missouri

When I arrived at Norwood Hills Country Club during the winter of 1963-64, weeds were nearly 60% of the total cover in the fairway. Norwood has 36 holes, and therefore I will refer to a particular 18 hole golf course from here on as the West or East Course. It was decided to maintain the desirable turf and selectively eliminate the undesirable weeds. The fairways were badly infested with knotweed, crabgrass and goosegrass. Of minor importance, dandelion, buckhorn plantain, common plantain and chickweed were all present.

The West Course was in the worst shape. Some years ago an attempt was made to plant U-3 Bermuda. Weed competition and the lack of an irrigation system hindered any progress by the bermudagrass. And the annual weeds took over rapidly.

The East Course was 30 to 60% weed infested, but the encouraging part was that there was not a general weed infestation, but a patch here and a patch there. This brought to mind grub damage pattern, and in the places where grubs had damaged the turf, weeds took over the area. Right next to the weed patch was a dense, healthy sod of bluegrass.

So, the Club decided to take the plunge and go all out on a weed control program, knowing full well that bare ground was inevitable and unsightly fairways were probable. The West Course received only broadleaf weed control for two reasons. First, the West Course had the least amount of desirable turfgrass, and had I killed all the weeds and the crabgrass and goosegrass, there would have been too much bare ground. Secondly, without an irrigation system I could not guarantee any germination of a temporary turf. So, I killed the broadleaf weeds and prayed for the crabgrass to cover! I started my spray program by purchasing a 30 feet spray boom. This proved to be too long, so skids were added to support the boom ends to maintain the desired height of the spray nozzles above the ground.

I started spraying with 1 lb. of actual 2,4-D amine, 1 lb. actual Banvel-D, and 12 oz. of wetting agent in 25 gallons of water. This was sprayed through a nylon

roller pump at 60 psi. With the 30 foot spray boom, I was able to spray about 15 acres an hour. The initial rate proved to be a little too strong. In the overlap areas the actual application rate was 2 lbs. of material per acre. This produced some tip burning of the desirable grasses due to a drouth stress condition. I, therefore, cut the rate to 1/2 lb. 2,4-D Amine, 1/2 lb. Banvel-D, and 12 oz. wetting agent in 25 gallons of water per acre. This combination produced excellent results, but took a little longer to kill the weeds. This application to the West Course was sprayed the last week in April. I wanted to spray earlier, but strong surface winds caused the delay. Within three days time the knotweed and all other weeds were bleached yellow and were limp. The affected weeds were so dramatically killed that a string line could be laid between the sprayed areas and the unsprayed ones. One application was all that was necessary for the West Course.

One section of a fairway, or approximately 1 acre in area, had been plugged on 2 foot centers with Meyer zoysia, and the competition from weeds had been so great for two years that the Zoysia plugs were still 2-3/8 inches in diameter. When the weeds were killed the area was just too barren to hold a ball and the golf balls rolled back down the hill. On June 8, 1964 I removed every other knife from an aeroblade so that the knives were then on 4 inch centers. I ran the aeroblade two directions across the fairway and the net results were slits in the ground 1 inch deep in a diamond shaped pattern. I then applied 50 lbs. of Hulled Common Bermuda grass, 320 lbs. of 5-20-20, and 100 lbs. of a Urea formaldehyde type 38% N fertilizer, and dragged the area in two directions with a chain-link mat. By dragging hose 200 yards and watering small areas at a time, we were able to water this acre once. On June 15, 1964 the Bermuda was up and going strong. The impressive point was, that the only place any Bermuda germinated was in the slits mechanically made in the soil. The seed was broadcast and I know that plenty of the seed was on the surface of the ground. The diamond shaped pattern was quite pronounced. The players wer as amazed as I at the seemingly "over-night" change that occurred.

The East Course had a much larger per cent of desirable turf. For this reason, a complete broad-leaf weed control program, plus a crabgrass-goosegrass control program, were decided upon. On April 15 forty acres of fairway on the East Course received 450 lbs. of powdered tri-calcium arsenate per acre. This material was applied through a bin-type spreader. On April 16 a gentle rain removed the material from the leaves and then stopped. At the time of application crabgradd had germinated, chickweed and knotweed were present. The tri-calcium arsenate killed all the weeds included above. All the weeds mentioned, except knotweed, failed to reoccur in these fairways. The crabgrass and goosegrass on the East Course fairways were completely controlled. By the latter part of June the knotweed was again competing in the fairways. The East Course fairways had only tri-calcium arsenate applied in April, and no further weed control was necessary at that time. So, on July 3, 1964, with the temperature at 90°, I sprayed 1/2 lb. Banvel-D, 1/2 lb. 2,4-D, and 12 oz. wetting agent in 25 gallons of water per acre at 60 psi. In three days time the weeds yellowed, wilted and began to die just as effectively as in the spring application on the West Course. Rhizome activity of the bluegrass turf was good most of the summer.

During the last week in August and the first week in September, all fairways on both courses were thatched with the aeroblade, and 50 lbs. of Common Kentucky bluegrass was applied with a bin-type spreader. Urea was applied at the rate of 100 lbs. per acre, and the chain-link mat dragged the fertilizer into the slits. Since soil tests had shown a phosphorus and potash content quite adequate, straight nitrogen was used all year to help obtain maximum control from the tri-calcium arsenate. The seed germinated well, but had difficulty surviving the long dry fall.

Currently a completely automatic irrigation system is being installed on all 36 holes. I hope in the future to be able to show you the "after" effects of the program now started.

- - - - - - - - - - - - - - -

PROTECT FAIRWAYS FROM COMPETITION

Dr. Fred V. Grau, Agronomist,
College Park, Maryland

Competition is a contest between rivals. Considered in the light of fairways, we may assume first that we are dealing with a mixed population where, let us way, two grasses are growing. One may dominate the other to the detriment of the turf. An example could be common Kentucky bluegrass and annual bluegrass where the aim is to discourage competition from the annual bluegrass. Devices that we can use to protect common bluegrass from the competition of annual bluegrass include:

1. Let soils become so dry that annual bluegrass will wilt and die. The difficulty here is that we cannot control the rainfall.

2. Reduce or prevent seed production. If no seeds are produced, annual bluegrass will be unable to reproduce itself. Chemical sprays can reduce seed formation. Sodium arsenite at one to two pounds per acre has been used. Maleic hydrazide has potential, but I've seen no recommendations for this purpose. There is hope ahead for some of the pre-emergence chemicals.

3. Assist the bluegrass to overcome weaknesses, such as susceptibility to Helminthosporium leafspot disease. Fungicide sprays may help, but one is still stuck with a week grass that is still susceptible.

4. Fertilizer to strengthen the common bluegrass at a time when annual bluegrass cannot take full advantage of the nutrients. Use fertilizers that tend to discourage annual bluegrass, if such a thing is possible.

   In bluegrass areas it would be more to the point to introduce Merion bluegrass, which could help keep Poa out by stronger growth, greater resistance to leafspot in spring and greater tolerance to close mowing, which is demanded. There are newer bluegrasses under test now that give promise of even greater success in protecting from competition.

Then there is the competition from weeds. In this field there are several materials which show great promise. I have here the most recent recommendations from Penn State. With vigilance, close attention to developing good soil conditions, adequate balanced fertility and good management, it is unlikely that weeds ever again will be a serious threat to any turfgrass area.

Competition from insects can hardly be considered a serious threat. Our entomologists and the chemists have teamed up to give us near-perfect controls. We need not elaborate at this time.

It would appear that our greatest trials come when we attempt to develop fairway turf from weak, undependable, unadapted grasses. One hears the familiar refrain, "Once you have Poa annua you've got to live with it." This means fungicidal treatments when diseases threaten, constant watering and cooling to hold it during hot weather.

Those who have bentgrass fairways and mow them closely, as they should be mowed, can look for competition to come from: 1) clover, 2) knotweed, 3) insects, 4) diseases, 5) annual bluegrass. These are the major ones - there are other. The watchword is, "Go easy on the phenoxys."

The man who plants Highland and Astoria in the belief that he will have a non-creeping colonial bent turf can look for competition from the bastard creeping strains that are poor turf types, but are vigorous and will dominate the turf completely. One approach is, since the turf eventually will be composed of creepers, why not discourage competition right at the start and plant Penncross. Of course it will develop thatch. All creeping bentgrasses will. Considering that thatch is a form of competition, how would be hold thatch to a minimum? First, reduce N fertilizer to promote minimal growth consistent with divot healing. Next, lengthen intervals between irrigations so as to avoid stimulation of excess growth. Keep pH valuve of soil at optimum for thatch-consuming micro-organisms (6.5 to 7.0). Mow closely, under 1/2 inch, and use thatching machine and trash removal unit when needed. Soil cultivation with cores spread for topdressing will encourage thatch breakdown. Regardless of the new chemicals, let us keep in touch with the arsenates for the several things it does for high-quality turf.

Those who operate close to the crabgrass belt and who are planting Zoysia have started to solve nearly all problems of competition. True, the billbug may threaten and the desert termite might invade, but they are no match for modern insecticides. The annual bluegrass that will invade during fall and winter months is desired and need not be considered competition.

In this discussion I have introduced nothing new - only evaluated some of the tools available to us for reducing competition from any source. The job is infinitely more difficult when we start with weak, soft grasses that have invasion stamina only during a short period of the year. We must continue to work for the perfection of grasses so sturdy that all these artificial guards against competition will become virtually unnecessary.

- - - - - - - - - - - - - - -

KEEP BLUEGRASS GROWING

James M. Latham, Jr., Agronomist, Milorganite Turf Service,
Milwaukee, Wisconsin

For golf course fairways through most of the Midwest, I think bluegrass is almost impossible. The pressure by golfers for lush, green, closely-cut grass eliminates present bluegrass varieties from consideration. Re-education may be possible, but is not probable under current conditions. Why is bluegrass so condemned?

Height of cut is a primary factor in bluegrass utilization. In general, the lower the cut the more rapidly will an established stand degenerate. Various minimum heights have been quoted that largely vary, according to climate and other management programs. A current procedure is to cut fairways under an inch in the spring and fall, then raise the height during hot weather to $1\frac{1}{4}$" or so. In 1933, however, the Green Section recommended higher cut in the spring and fall with closer cut during the summer.

When the reversal took place we don't know, but the two schools of thought are widely divergent. Brown's work in Missouri substantiates the 1933 opinion, since the spring and fall periods produce maximum growth and storage of reserves in rhizomes. During hot summer weather, this is slowed drastically.

Golfers are often said to be color blind -- if it's green it's good, if not -------. The normal hot weather dormancy is no longer permitted because of irrigation capabilities, and the reserves are further depleted.

If sod density can be increased and ragged appearance decreased, we may be able to achieve the higher cuts. This will mean better timing of fertilizer applications and reconsideration of nitrogen sources. It will mean use of irrigation for the sake of the grass and not to make the fairways more comfortable to walk upon. It also means more frequent cutting to provide a smoother upper surface we hope the ball will be resting upon - not within.

To make the most of what we have to work with calls for careful programming of good management when permitted. Spring and fall fertilization are musts to provide adequate nutrition during these preferred periods. Fall irrigation, when needed, is also extremely important to healthy growth. These applications of fertilizer should provide ample supplies of phosphorus when needed. Juska's test applications of P_2O_5 up to 4,000 lbs. per acre continually improved bluegrass top growth and had no deleterious effect on roots.

Much is made of disease invasions into pure stands of bluegrass. Perhaps more thought and testing should be given to mixtures of bluegrass varieties to lessen this tendency. The key, however, remains height of cut and over-use of water. As new varieties of bluegrass appear, these limiting factors may be reduced. Today, though, unless cutting heights are up to 1-1/8" or 1-1/4", little comfort can be given those who remember the good bluegrass fairways of yesteryear.

Midwest Turf leaflet No. 29 "Bluegrass Fairways, Yes, If?" is available from W. H. Daniel, Dept. of Agronomy, Purdue University. It summarizes current thinking on maximum turf care.

SOIL TEST RESULTS AND INTERPRETATION

James M. Latham, Jr., Agronomist, Milorganite Turf Service
Milwaukee, Wisconsin

Soil testing is far from being a completely exact science, but it is a very usable tool to approximate nutrient deficiences in soils. Modern tests do not measure the total amount of nutrients in a soil. They estimate the amount of a nutrient that is available to plants. Soil tests are meaningless unless the numerical results are correlated to plant response. We must "ask the grass" if additions of a certain nutrient will benefit its growth. From field testing of laboratory results, limits are set on deficiendes and excesses of various elements.

There are three critical steps that must be carefully taken to make a soil test meaningful. The first is PROPER SAMPLING. For turfgrasses, we feel that an 0 to 2" depth is best. Although the root system may be deeper, this depth is a measure of the feeding zone and more recent additions of nutrients. It is also the depth for phosphorus accumulation, as well as calcium and magnesium, following a surface application of dolomitic limestone. Deeper samples dilute these elements and can give a misleading result.

The second critical area in soil testing is the CHEMICAL ANALYSIS. Procedures are based on using chemicals to approximate uptake by plant roots. Extraction must be rapid and not remove the fractions of nutrients unavailable to plants. Analysis procedures must be worked out on a routine basis and carried out by experienced per-

sonnel. Newer devices are now being used to provide extremely accurate measurements of available nutrients. Small errors in adding reagents, unclean apparatus and poor judgment can be a direct source of error.

The third critical phase is RECOMMENDATIONS for treatment based on soil test results. To make these recommendations, one must have some knowledge of the physical properties of the soil tested. He must know the type of grass to be grown and the purpose to which it will be put. He must know field correlations to the laboratory results. In the latter case, it is almost impossible to pick up any soil test report and make recommendations unless one knows what nutrient levels are considered low, and the point at which additions of a given nutrient no longer produce growth responses.

Liming recommendations are based on acidity, calcium and magnesium readings, but are very dependent on the texture of soils. Sandy soils need less lime to raise the pH than those with high clay content. Recent research at Wisconsin has also shown that calcium and magnesium should be present in a ratio of not more than 10 to 1. If calcium content is above this, a magnesium deficiency can be produced even though there may be an adequate total amount in the soil.

The maintenance practices are also important. If clippings are to be removed from the area, significant potash losses can be expected through harvesting. These losses must be periodically replaced. On the other hand, if clippings fall back into the sod, normal decomposition will return this nutrient to the soil solution. Florida research has shown that, contrary to popular belief, potash losses due to leaching are not as great as once thought.

High phosphorus levels have been condemned for a long period of time. This condemnation has been based on tie-up of iron and the need for higher arsenical application for pre-emergence control of crabgrass. Recent U.S.D.A. research by Juska shows, however, that no damage was done to bluegrass or creeping red fescue at rates up to 4,000 lbs. of P_2O_5 per acre. This is the equivalent of 10 tons of 20% superphosphate per acre. His test used 46% material, a low sulfur source of P. In fact, top growth increased with increased P and no root reduction was noted.

Salinity tests may become necessary in some midwestern areas because of the increased use of salt for ice removal on streets and sidewalks. Many cities are already facing a crabgrass and knotweed problem along streets due to the inability of bluegrass to tolerate high salt content.

With new, high analysis fertilizers, minor element deficiencies are becoming definite problems. Sulfur deficiencies are alreadh well known in Florida. Boron has been shown deficient in many areas, as has Molybdenum.

Some of these minor or trace elements are as detrimental in excess as they are when deficient. Manganese, zinc, copper, and boron are among them. For this reason, it may be necessary to set minimum and maximum limits when suitable soil tests are devised and in use. Copper toxicity has already occurred in some of the citrus areas in Florida, although it is needed in small amounts. This shows the hazard of a shotgun minor element application to remedy the deficiencies of only one nutrient. If iron is thought to be deficient, apply only iron. If this fails to work, check only one element at a time to avoid excess amounts of others.

The O. J. Noer Research Foundation has established a grant for long time research on soil testing techniques at the University of Wisconsin. This is especially aimed at soils on which turf is to be grown. Through continued research, both in laboratory and field, soil testing will become more accurate, and hence, a much more useful tool than it is today.

TURF RENOVATION

J. R. Watson, Director, Agronomy Division,
Toro Manufacturing Corporation, Minneapolis, Minnesota

To renovate means to restore to life, vigor or activity; to renew, make over, or repair. Renovation is the technique or procedure involved in the restoration, or renewal process. Renovation of turfgrass areas is generally undertaken when some basic factor or condition -- which cannot be corrected by proper management practices - causes turf quality to deteriorate to the point where it is unacceptable from the standpoint of play or appearance. The degree of renovation required to produce satisfactory and acceptable turf can be determined only if the basic cause of the poor turf can be ascertained.

For purposes of clarity, and in keeping with the general concepts of the title, renovation should be distinguished from rebuilding. The grouping of practices and the terms used to describe each category is necessarily arbitrary and an overlapping of techniques is recognized.

Renovation. A term used to classify those practices, which lie beyond the scope of routine maintenance, and which, if performed, will (1) produce a satisfactory response from the current management program,,or (2) reduce an abnormal expenditure of management efforts (time, materials, equipment and supervision) required to maintain satisfactory turfgrass. Practices that would be included in this category are (1) the introduction of a new strain of grass, (2) elimination of excessive thatch and mat accumulations, (3) correction of faulty surface drainage, (4) replacement of tile or installation of "dry" or "french wells" to restore proper subsoil drainage, (5) incorporation of amendments, or severe cultivation to alleviate soil compaction, and (6) elimination of tree roots.

Rebuilding. A term which refers to those practices involving complete changes. A modification of soil texture, corrective subgrade contouring -- with or without installation of tile, reshaping of surface grades and contours -- crowning of football fields -- and relocation of a specialized turfgrass site, would be included in the rebuilding category.

Management. Practices such as fertilizing, watering, aerating, mowing -- including vertical to control thatch -- and the control or elimination of disease, insects, and weeds are normally performed in a routine maintenance program. Failure to perform satisfactorily or adequately, one or more of these practices, could lead to a decline in the turf quality. If such is allowed to persist, renovation may be required to restore the turf.

Planning. Once the decision to renovate a turf area has been made, a plan for the job needs to be developed. The plan should include:

1. A definition of the problem. This would show why the turf decline.
2. Proposed solution. This section should show when the job will be done (when the permanent grass is actively growing), what will be required to restore the turf site to suitable conditions and who will do the job -- contractor, sub-contractor, or individual.

3. Alternate solution -- including leaving it alone. Always keep in mind that status quo may be the most satisfactory answer, at least acceptable, to a problem.

4. Costs. Cost schedule should include equipment costs (buy, lease, rent, or borrow any specialized units required), materials -- the kind and amount of soil sterilants, or other weed control chemicals, fertilizers, soil conditions,(peat, calcined clay, sand, etc.) and seed. Finally, the cost schedule should show labor costs.

5. Advise officials and other concerned as to when the job will be done, etc. This is a most important consideration when dealing with playing fields of other sites that may be needed for practice or special events.

Finally, when the work is completed, remind the manager of the site why the job was necessary and caution him to avoid, insofar as possible, similar conditions or situations on the newly renovated area.

- - - - - - - - - - - - - - - -

BUSINESS PRACTICES EMPHASIZED AS ESSENTIAL FOR A GOOD SOD OPERATION

Victor Keigley, Red Hen Turf Farm
Berrien Springs, Michigan

A. BUSINESS PRINCIPLES

1. Have as much or more concern for your customer as you have for yourself.
2. Make sure that a customer receives a dollar's value for a dollar spent.
3. Honesty always pays in the long run.
   a. It pays not only in dollars, but most important in personal satisfaction which is the real true value of anything. "For what good is it for a man to gain the whole world and looseth his soul."

   b. If a man cannot feel proud of the product he is selling, and proud of the service that he is giving this customer, then I don't think he should be in business. In most cases he won't be in business too long if he doesn't feel this way.
4. Now that we have our values in the right place, let's talk about some of the things that we will want to do to fulfill these values of good business.

B. MARKET

1. It is important that the farm be located in such a place that one can serve as large a market as possible in all directions. I would think that a market in one direction only wouldbe very vulnerable. Where there are markets in all directions, one need only to get his share of the business and still have a good business. This gives the good grower with high principles a chance to sort out the good business from all markets, and maintain a profitable business. A good grower has something to say about the class of clientele that he wishes to serve.

C. ORGANIZATION

1. We have learned the importance of dividing and delegating the responsibilities for an efficient operation. These responsibilities are divided into three

parts for best results.

a. RESPONSIBILITIES OF GROWING AND PRODUCING AMPLE QUALITY SOD

1. If a business has set its principles high and has the welfare of his customers at heart, there is no question but what the best of quality is none too good. The man that buys the cheapest seed (not thinking of his customer nor himself) to save a dollar, is not thinking of quality sod.

   A grower who plants many acres of sod without the irrigation facilities to properly irrigate the seedings and sod, is not thinking of his customers nor himself in the future. Whenever one puts every effort forth to better serve this customer, he is also going to be equally rewarded dollar-wise over the years. Irrigation facilities are a must in order to insure good seedings, and to insure the proper amount of moisture before cutting. Poor quality sod not only hurts the man that is growing the sod, but the customer who is buying, as well as the industry itself. But, be assured that the man who continually has nothing but the best quality of sod will always remain in business. We find that the greatest per cent of the customers want nothing but the best. Too many growers are afraid to lose a sale when a customer wants to buy a cheaper product for less money. Quality sod growers only hurt themselves when they meet the low quality sod prices.

2. Following are the responsibilities of growing and producing ample quality sod:

   a. Know the number of acres required to meet the needs of the business.
   b. Prepare the seedbed, soil treatment for insect control, fertilization, planting seed, irrigation of seedbeds, weed control, mowing, fertilizing and irrigating until ready for cutting.

b. RESPONSIBILITIES OF SERVICE

1. We place service second to quality product and ahead of sales in importance, because you don't have anything to sell until you have a quality product and the service to serve the customer efficiently.

   Service responsibilities are very closely coordinated with sales and consist of cutting and loading in the field for pick-up customers, as well as cutting and loading of all orders to be delivered by our trucks. No excuses and few reasons are tolerated for being late on a delivery, or for a customer to wait over 10 minutes before his truck is to be loaded.

   a. This is accomplished by a constant educational program whereby the customer always calls in advance to make arrangements on the time for his pick-up or delivery. Once he is scheduled for a time to be loaded at the farm, or a delivery date at the job, he can expect this commitment to be met. Anyone coming in without an appointment must wait until all other commitments are met. Customer soon learns that it is to their advantage to

schedule in advance. This sytem also helps to eliminate frustrations at the farm by keeping the customer happy and keeps things running smoothly at the farm. No truck driver is expected to help load his own truck. We want the truck driver to want to come to our place of business for prompt and courteous service. How many of you have gone to a barber shop to get a haircut only to find that there are six or seven people ahead of you? Irritating isn't it? There are many barber shops that operate by appointment only. This day and age time is of greater importance, and a certain clientele will patronize this kind of service.

b. If a customer calls in for a load of sod and the schedule is filled completely for that day, he is politely informed that we cannot serve him at that particular time, but can give him prompt service at a specific time and date. When a customer is irritated at this and goes to your competitor's place of business and waits for several hours to be loaded, he soon appreciates the appointment service and calls several days in advance for his orders. He may be irritated at not getting an appointment at his convenience, but he is irritated more if he comes in and waits several hours before being loaded.

c. One of the greatest services that has contributed to customer satisfaction is the pallet fork-lift service. All sod is delivered to the customer's job on pallets and is unloaded with a fork-lift and placed on the job at the customer's desire.

d. There is nothing that gives us greater satisfaction in our business than the satisfaction expressed by our customers in regard to prompt service and quality product. We maintain these two things to be of the highest of importance and will result in a profitable business.

c. SALES AND COLLECTIONS

1. We have placed sales in the third spot of importance, for without the quality product and the prompt service, you have nothing to sell. There is nothing like satisfied customers to make sales. We have one man whose responsibilities are sales and collections, and he works very closely with the service man coordinating delivery and pick-up dates. The schedules are always set up to allow plenty of time to meet commitments, for our most important slogan is "better early than late." Our pallet service is of great value in this respect. If we run ahead of schedule, our man goes right ahead and unloads the sod with the fork-lift-pallet service, and no time is wasted waiting for the customer. In many cases the sod is unladed and placed at the desired location by the time the customer arrives.

2. It is an absolute must that the man in charge of sales be available at the sales office so that any customer calling in, or stopping by can be given definite appointments, or any other desired information. There is nothing more disgusting than to call a place of business and not be able to get the information desired because a certain party is not available to give the proper information.

3. Peronal selling is of great importance. A new customer not familiar with our quality and service is always informed of these facts, as well as the price.

4. Advertising also is of great importance and consists of yellow page advertising, brochures, sod installation and lawn care instructions, and radio and newspaper advertising.

5. In regard to collections which is handled by the man in charge of sales, we have one slogan - "a sale is not a sale until the money has been received for that sale." In other words, it is better to lose a sale than to tie up money on a questionable sale. Anyone can sell, but selling and collecting for that sale means the difference between success or failure. When your quality and service is at its best, one need not be reluctant in demanding his money for his product and service.

D. EMPLOYER AND EMPLOYEE RELATIONSHIP

1. A book could be written on this subject, so we will leave this subject with one thought - Do unto others as you would have others do unto you. Abide by this rule and allow the responsible key men to prosper with you, and you will have a team that can't be beat.

E. SUMMARY, OR LAST THOUGHT

1. The greatest asset of any busines is HIGH BUSINESS PRINCIPLES. If one's business principles are right, everything else will automatically be at its best - "For what good is it for a man to gain the whole world and looseth his soul."

- - - - - - - - - - - - - - - -

WHEN IS SOD READY TO CUT

L. Mueller, Mueller Sod Farms,
Ontarioville, Illinois

My discussion will not be a pedantic or academic report - jurst a grower's viewpoint pertaining to the finished turf product, which we call sod. I would like to ask various growers to participate in this discussion.

Forty years ago when we were selling pasture grass for sod, my Dad and myself would scour the countryside looking for sod in pastures that had some quality and a very small percentage of weeds. This, of course, took time and patience, but we always seemed to come up with enough acreage to renovate for the season. When we found a pasture that looked good enough to strip, the first thing we would do was toop down and grasp two handsful of grass leaves and lift upward. If the grass parted from the roots, without the roots being disturbed, we knew we had a potential supply of sod. One can still rely upon this old-fashioned test to a great degree. Of course, it is not entirely fool-proof, but it has some merit.

The only fool-proof was to determine if sod will hold or is ready to cut is to place a sod cutter in the field and cut a few yards; then test it for holding ability by rolling it in rolls, or lifting a six-foot length by one end and holding it aloft.

Some purchasers will set their own specifications. Park districts, or some states, counties, or cities will demand the rolling and unrolling of a yard of sod 4 or 5 times before they will approve or accept an order of sod. I believe we ought to list the characteristics of sod ready to cut in the order of their importance:

1. Should appear to be disease-free
2. Should be weed-free
3. Should have heavy root and rhizome growth (holding ability)
4. Have a thick top growth
5. Should have a lush green color.

We could go on to relate how sod grown from quality seed can be obtained in the shortest possible time and costing as little as possible. Let us select a peat field of moderate fertility that has been in sod production before. One could seed this field dormant, or in early spring (in the northern part of Illinois, southern part of Wisconsin, and other areas in the same zone).

Twenty to 50 pounds of seed per acre is used by most growers. We prefer 35 lbs., at the same time an application of a 1-4-2 fertilizer may be applied. If it is a dry spring, water will have to be supplemented by irrigation. If we would seed a little later when the weather is warm, we prefer a solid set of irrigation pipe. By solid set I mean a field of 10, 20, or 40 acres would be covered entirely by 2 inch pipe and sprinklers, which are left in place until the seedlings are growing.

Four to 6 weeks later, depending upon water, temperature and grass growth, apply 300 lbs. of a 1-1-1 fertilizer ratio. In peat fields a solid growth of weeds may cover the grass in a very short time if temperatures are high. When this weed growth reaches a height of six or eight inches, we would apply 1 pint of 2,4-D (weed killer) in 15 gals. of water per acre. If the temperature is below 75°, 1-1/2 pints of 2,4-D should be applied. We have experimented with this practice for years and have not had any noticeable setback in the growth of the grass seedlings. On the other hand, if the weeds continued to grow,a greater part of the seedlings would die or become elongated and spindley due to the shade of the weeds.

The next application of fertilizer a 2:1:1 ratio would be applied approximately 4 to 6 weeks later, again depending upon the growth of the grass and the water applied. All other fertilizer applications would be of the 2:1:1 ratio. (One might use a urea 45% nitrogen also). When the sod or grass has completely covered the ground in its entirety and has developed a sod sufficiently strong enough to withstand extensive handling, harvesting can begin.

We have a very short film taken 2 years ago to illustrate the finished product being harvested, cut by machine, rolled by machine, and loaded on trucks.

- - - - - - - - - - - - - - - -

SEEDS MIXTURES - A REVIEW

Dr. A. S. Carter, Director, Seed Control
Purdue University

Turf is big business in Indiana and grass seeds for turf purposes are handled in carload lots. Seed Law enforcement plays an important part in the distribution of seed for turf purposes. The intelligent buying of grass seeds, as well as other seeds, involves buying on the basis of analysis, which inevitably leads us to considering the seed label as the key to an intelligent purchase.

Seed labeling is somewhat complicated, but everything on the prescribed label is important. When seed is purchased the purchaser should be especially interested in the percent of pure seed, which, for an item like bluegrass seed, may vary from 75% to 98%. The pure seed content can be too low and you will be paying for a lot of dirt, trash, and other forms of inert matter, or it can be too high and you may be paying an undue amount for processing necessary to achieve such a high percentage. The goal should be obtaining your money's worth. If the material in the bag is not pure seed, it may be either weed seeds, other crop seeds in which you may or may not have an interest, or inert matter.

One of the most important items on the seed label is the kind and variety. We must recognize that new varieties of turf seeds are being developed and becoming available, and the success of the turf enterprise may depend upon the variety of seed. The statement of pure seed on the label refers to the pure seed of the kind and variety, but unfortunately it is not possible to make varietal determination of all turf seeds by examination of the seed. For example, the seeds of Merion bluegrass can be differentiated from commercial Kentucky bluegrass, but many of the other varieties are indistinguishable. This means that if you are interested in a specific variety, it may be necessary to buy certified seed of this variety, do the mixing yourself, or have the mixing done on a custom basis.

As with all seeds, germination of grasses is important, but, for some species, it becomes very difficult. Certain grass species must be tested for as long as 28 days at alternating temperatures to simulate night and day temperatures. Some require light, or chemical treatment to break dormancy, and some must be pre-chilled to break dormancy. In other words, the testing of turf seeds is a very complicated and involved matter. You are professionals and we recommend that you leave the analysis of turf seeds to professional seed analysts who are better able to evaluate seed lots.

Reference above was made to seed certifications. Seed certification, conducted by Crop Improvement Associations in the various states, has as its primary assignment to assure that the varietal identity of the seed is trictly maintained through the multiplication processes. Seed certification also provides for certain quality standards so that the seed labeled as certified will be good seed, as well as seed of the variety claimed.

One question that may be raised is whether or not seed mixtures can be accurately tested. The answer is yes, if the sample is properly drawn, properly subdivided, and tested. A report on a seed mixture will give the percentage of each kind of seed present of each identifiable variety. As for all seeds, it will give the percentage of weed seeds, the percentage of other crop seeds, the percentage of inert matter, percentage of germination, and the number of noxious weed seeds per pound. However, as stated above, if you have serious interests in specific varieties that cannot be distinguished by visual examination, we cannot make this determination on the basis of a seed laboratory test. Here you must depend on certified seed.

We realize that many turf men are interested in avoiding seed lots containing Poa annua. Certainly Poa annua is not desirable in turf seeds and turf mixtures, and we anticipate that eventually a list of noxious weed seeds, especially designed for turf seeds, will be developed and that Poa annua will be aprime candidate for such a list.

The control laboratory in this state, as well as in many other states, can offer a distinct service to those interested in turf seeds. In the first place, continued sampling of lots of seeds as they appear on the market will give you strong assurance that the seed you buy will be as guaranteed on the label. We are proud to point out that in the year 1963 only 1.8% of all seed samples were found to be seriously mislabeled. The percentage was a little higher than this in 1964, but the label is accurate to a high degree.

Furthermore, if you live and operate in Indiana, and if you will let us know when you buy seed, we will be glad to have an inspector call on you, draw an official sample of the seed, make an official test, and report the results to you. In fact, we would like to get 25, 50 or more samples of seed sold to golf course operators and other turf handlers and would prefer to get official samples after the seed has been sold so that we can report results directly to you. Furthermore, if you have carryover lots of seed about which the germination is in question, we will be glad to run a germination test for you without charge if you will send us a representative sample during the months of November and December so as to avoid our rush season.

- - - - - - - - - - - - - - - - -

BLUEGRASSES - TODAY & TOMORROW

Dr. J. A. Long, Director, Biochemical Research
O. M. Scott & Sons Company, Marysville, Ohio.

Historical

John James Ingalls, a Senator from Kansas, paid quite a tribute to the bluegrasses in an address of his, printed in the Kansas Magazine in 1872. To provide us with a starting point on "Bluegrasses - Today and Tomorrow," a couple of sections of Senator Ingalls paper are presented.

"One grass differs from another grass in glory. One is vulgar and another patrician. There are grades in its vegetable nobility. Some varieties are useful. Some are beautiful. Others combine utility and ornament. The sour, reedy herbage of swamps is baseborn. Timothy is a valuable servant. Redtop and clover are a degree higher in this social scale. But, the kind of them all, with genuine blood royal, is Bluegrass."

"The primary form of food is grass. Grass feeds the ox; the ox nourishes man; man dies and goes to grass again, and so the tide of life, with everlasting repetition, in continuous circles, moves endlessly on and upward, and in more senses than one, all flesh is grass. But all flesh is not bluegrass. If it were, the devil's occupation would be gone."

Before reviewing the status of bluegrasses at the present time and for the future, there are a couple of additional historical points that would, perhaps, be of interest to you. As early as 1665, the term English grass was used to describe both bluegrass and white clover originating in a report from Rhode Island (1948 Yearbook of Agriculture).

In 1785, Thomas Jefferson, in his Notes on the State of Virginia, stated: Our grasses are Lucerne, St. Foin, Burnet, Timothy, ray (rye) and orchard grass; red, white and yellow clover; greensward, bluegrass and crabgrass."

Recent Seed Production Statistics

Seed production figures on bluegrass are of interest since the production and movement figures provide some insight to the scope of the industry from year to year. Disappearance figures, which indicate market consumption, show that the bluegrass seed industry is substantial.

Some Bluegrass Seed Production Statistics (USDA)

		Pounds	
Merion			
Carryover (1962	1,900,000		
U. S. production in 1963		3,300,000	
Imports during 1963		800,000	
		4,100,000	
Disappearances during 1963			4,600,000
Other bluegrasses			
Carryover 1962	11,000,000		
U. S. production in 1963		15,000,000	
Imports during 1963		16,500,000	
		31,500,000	
Disappearance during 1963			32,400,000
	1963 total use		37,000,000

Bluegrass Varieties

Currently available in the Midwest

The varieties below are generally available today. Currently several companies are blending these for best disease tolerance, longer vigor periods and wider adaptation.

1. Common - The total of all unnamed material reaching the market, whether produced in midwest, northwest, or imported. Also that harvested from surviving stands in old pastures and fields. Generally considered leafspot susceptible, medium in vigor and leaf width.

2. Merion - Selected in 1935, released by Pennsylvania in 1948. Has good leafspot resistance, but susceptible to stem rust in fall and powdery mildew. Needs good fertility.

3. Newport - Selected in Oregon in 1937 - released in 1948 - medium in leafspot tolerance, resistant to stem rust, susceptible to leaf rust. Blends well and supplements Merion. Needs good fertility.

4. Delta - Selected in Canada in 1935, released in 1958, but little grown until 1951, then expanded production. Looks like Common, but more vigorous - only medium in disease tolerance.

5. Park - A collection was started in 1937 - from these a blend of 16 preferred individual clones was released by Thomas of Minnesota in 1957. Turf appears similar to Common, with leafspot susceptibility.

6. Windsor - Selected in 1949 by Renner of Scotts in Ohio - released as private variety by Scotts Seed Co. in 1962 - color and disease resistance similar to Merion. Needs good fertility.

7. Arboretum - An early selection by Shaw's Arboretum in St. Louis, Mo. - quite susceptible to leafspot - texture is similar to Common. Very little grown.

8. Beaumont - Selected by Scotts - uniform and stable apomictic with growth habit and texture similar to Park - blended with other bluegrasses.

European Sources

European growers are well organized through seed houses that control their individual varieties. Imports of all grass seed, particularly bluegrass, indicates increased supplies will be available. The several varieties are listed only for your information.

1. Prato - Selected by Van der Have in Holland and widely sold in Europe. Now marketed by Northrup,King (started in 1963) as part of their Golf Brand - Appears to be finer than Merion or Windsor - produces a dense turf, medium tolerance to rust.

2. Delft - Formerly called C. B. - recently released by Centraal Bureau of Holland - blue-green color, medium density, leafspot susceptible.

3. Campus - Selection of Van Engelen's of Holland - mod. susceptibility to leaf-rust.

4. Golf - Selected and increased in Sweden - Highly susceptible to leafspot. Texture and growth similar to Common.

5. Cambridge - Older selection from England, coarse-textured, little used.

6. Kenon - Similar selection to Delta, from Canada - little developmental work.

7. Primo - Selected by Weibull's in Sweden - currently considered one of the better varieties in Europe - little information here.

8. Atlas, Melle, etc. - are other selections.

Experimental Stations

Several experimental stations (Purdue, Pa., Minn., Washington, Ky., and Kansas are example) and several companies (Scotts, Rudy-Patrick, Ferry-Morse, and Northrup, King are examples) are actively selecting and testing potential new varieties. Some are listed below for current information:

1. K-5(47) - (experimental Penn. - Musser) rust tolerant, leafspot tolerant, currently being tested at numerous stations. Duich feels it would best be blended with other bluegrasses. Not released by 1965.

2. K-1(61) - (experimental discarded by Penn.) leafspot resistant, very rust susceptible.

3. Anheuser dwarf - Selected in 1952 by Daniel of Purdue from Anheuser lawn in St. Louis, compact growth and relatively good leafspot tolerance. Makes open, thin turf (and not considered worthy turf type by Daniel).

4. Troy - Selected in Montana, heavy seed producer, but open, coarse turf, and not desirable fine turf, very little sold.

5. NuDwarf - Selection during 1950's by R. H. Rassmussen in Nebraska based on its shorter growth and green color, very limited observations elsewhere as yet.

6. Cougar - Several selections were made by Washington Agri. Exp. Sta., and labeled PNW's (205, 402, 602). These are moderately susceptible to leafrust, resistant to leafspot and good turf formers. In 1964 three best were equally blended and released as Cougar.

7. A-10 - A vegetative propagated (sexual) selection on which vegetative patent has been requested by Warren's Turf Nursery of Palos Park, Illinois.

8. S-21 - Geary, etc., are used to produce small amounts of seed. These and more may reach the market blended together and sold as Common bluegrass.

Present Plant Breeding Methods

The general procedures presently being used in research for generating source material from which new bluegrasses are being developed include:

Method	Probability of Success
A. Natural Occurring Off-types	Good
1. Lawns, golf courses, etc. - survival	
2. Pastures - adaptation	
3. Mass space plantings - differences	
B. Hybridization	Limited
1. Single cross	
2. Polycross	
C. Induced Mutants	Fair
1. Radiation	
2. Chemicals	

Of the three general methods, the selection of abberant, or off-type plants occurring in large space plantings, lawns, etc., has been by far the most effective and productive in this country. In fact, all of the improved bluegrass varieties that we are presently using have been developed by this method. It is recognized here that some of the desirable abberant of off-type plants eventually selected and released may have been a product of natural hybridization in addition to sexual seed formation. Controlled hybridization has yet to be established as a means of improvement for bluegrasses. Inducing mutant types with chemicals and radiation is being used with some success in breeding programs in Europe. Limited research in this area is being carried out at Beltsville, and in some private breeding programs.

Not being able to utilize hubridization imposes rather severe limitations and restricts flexibility in plant breeding programs. For example, if one selected an out-

standing accession of bluegrass possessing very desirable turf characteristic, except that it is highly susceptible to stripe smut, it would be possible, in plants where crossing can be carried out, to incorporate genetic resistance. Desirable plant type could then be restored, if necessary, by a backcrossing program. The procedure for all practical purposes would not be feasible for bluegrasses at this time because of a predominant seed forming process called Apomixis.

Apomixis

In grasses where the normal sexual reproduction process occurs, one nucleus fuses with the egg cell, the other with the two polar nuclei following pollination. The fertilized egg cell differentiates to form the new embryo plant; the triple nuclei form the endosperm. The major deviation in the process in bluegrasses occurs when the egg nucleus begins to divide and with subsequent divisions forms an embryo before fertilization can take place. When this happens it is not possible for the male nucleus to fuse with the egg nucleus. This process is called apomixis. The significant point here is that if we wanted to combine a male nucleus, containing hereditary factors from bluegrass plants resistant to a disease, with the egg nucleus of a bluegrass plant susceptible to the same disease, it could not be done because of apomixis. Popular terms refer to this as asexual seed formation or agamospermy. It certainly would be a major contribution if someone would develop a procedure to prevent the spontaneous development of the egg cell into an embryo without fertilization. As you can see, we understand what the problem is, but to date we do not know how to correct it.

Future Prospects

Considerations in Improvement Programs

After one has developed some scheme to isolate or collect new sources of plant material as potential new bluegrass varieties, several other factors enter into the picture in the total program for developing better varieties of bluegrass. Selection for disease resistance certainly should be a major consideration in all lawngrass breeding programs. Controlled artificial inoculation procedures under greenhouse conditions to determine status of genetic resistance to various plant diseases has not been too effective. Recent research conducted at the University of Minnesota indicated that Merion possessed no greater degree of resistance to Helminthosporium sativum than common or other bluegrass varieties when employing disease inoculation procedures under greenhouse conditions. In Central Ohio we do not see much leafspot development on even the most susceptible varieties until the second and third years after planting. Again the degree of infestation from year to year will vary under field conditions.

What does this mean to those conducting an improvement program? Careful planning must be done to obtain information on levels of resistance to the disease organism early in a breeding program. A procedure that is used now by several groups is to locate selection material in regions of the U. S. where disease activity is know to be most prevalent. We find it quite effective. For example, it is possible to obtain information rapidly on selections reactions to leafrust along the West Coast. The same is true for screening of selections for leafspot tolerance. This procedure not only assures that more accurate information is obtained on diseases resistance, but also provides data on general adaptability of bluegrasses to different climates.

Another aspect of improvement of bluegrasses is again related to apomixis stability as effected by different environments. It is possible to find high levels of asexual seed formation at one location; yet, when moving the same selection to another region, apomictic stability is lost to a great degree. This can have a marked effect on uniformity of a selection. Abberant or offtype plants resulting from sexual seed

formation are characterized by textural difference, disease resistance variation and generally reduced vigor.

Blends for the Future

The use of varietal mixtures in lawn seed products has been a widely accepted practice for a number of years. Several beneficial factors have generally been claimed for varietal mixtures as follows:

1. Wider adaptation to varying climate conditions such as temperature, moisture, light, humidity, and air movement.

2. Wider adaptation to varying soil conditions.

3. Less likely to be completely decimated by one or more disease and insect pests.

4. Very costly, highly desirable selection or varieties can be made available at a lower price when less expensive varieties are blended.

Sufficient attention has not been given to the compatability of varietal mixtures. For example, the benefit of less vertical growth would not be realized for a given variety that possessed a growth profile at the opposite extreme. If, however, the blending of varieties with very similar growth profiles was used, then this benefit of fine turf would be more realistic. We have observed a striking example of compatabilities in regard to leafspot disease activity. An increase of 20 per cent in susceptibility to leafspot was noted when Common Kentucky bluegrass was used in place of Newport in a varietal mixture with Merion and Windsor.

Further research on varietal mixtures would appear to have merit and should find immediate use for fine turf applications.

The Status of Research and What Next?

Future prospects for the development of improved bluegrasses looks promising, even though some rather difficult problems exist. The reasons for anticipating developments of improved bluegrasses are:

1. More specialists with better training are working in the area now.

2. Increase in financial support of both private and public turf research.

3. Improvement in techniques, methods and equipment.

4. Competition in the market place has increased tending ro force more concentrated efforts.

5. Varietal protection through patenting to provide a limited monopoly for industry.

It is anticipated that improvements will be forthcoming for some of the following characteristics of bluegrasses:

1. Increase resistance to major diseases
2. Low profile of growth and improved turf forming ability
3. Better regional adaptation.

The intent here has been to provide a brief status report on what is available today in bluegrass varieties, some general limitations of the present grasses, the size

of the industry as reflected in seed production and consumption, the problems involved in programs to develop better grasses, and last the probability of success in continuing to develop better bluegrass.

- - - - - - - - - - - - - - - -

PROGRESS IN BLUEGRASS RESEARCH

Charles D. Berry, Graduate Stuent
Purdue University

Progress is a rather optomistic word when referring to any research program, for we all know the pitfalls of a research scientist. Yet, let us explore this bluegrass program.

Any research problem must have reasons for the initiation of the research. To determine the genetic variability inherited within Poa pratensis, Kentucky bluegrass, population, this experiment was designed to contribute information about the genetic variance, heritability values, and the correlations among characters. In order to obtain data that would be worthy of such conclusions a representative sample of the Poa pratensis population was needed. Fifteen entries from some exotic plant introductions and from selections within the United States were chosen.

Individual plants of these selections were space-planted on two-foot centers, in eight replicates of a randomized, complete block design. From these plants individual data was taken on several turf characteristics:

1. A measurement of scoring of leaf width in millimeters.
2. " " " growth habit as a visual rating
3. " " " prostrate to upright
4. " " " leaf angle - a visual rating from 90° to 10°
5. " " " total spread as a relative measurement of the maximum to the minimum
6. Extension of the shoots measured twice during the growing season
7. Sod spread - a relative measurement
8. Total spread dense enough to be considered sod
9. Rust resistance - a visual score of the per cent leaf coverage by pustules.

This data was then transferred to computer cards for the statistical analyses. From these analyses on variance components, it was determined that significant genotpyic differences exist within these selections. This conclusion indicated that although the environment contributes significantly to the appearance of the grass, the genotype is a major component, and that the genotypes vary widely for the characters studied within these slections.

By the use of the Duncan's mutiple range test, which is a method fod etermining differences between means in a ranked array, groups of entries superior for each character were determined. From these analyses (based on one year's records) four selections were found to be superior for the characters measured. These were:

1. A selection from the Chicago Golf Club, 16-F.
2. An introduction from Yugoslavia, PI-25 1429
3. Plants from seed harvested from Merion bluegrass surrounded by C-1 bluegrass
4. Plants of seed harvested from Merion bluegrass surrounded by rust-free dwarf.

Heritability values, the fraction of total variance attributable to genotypic variance, was computed for each character. It ranged from 0.91 for total spread to 0.98 for leaf width. The values are higher than expected, but indicate that the variance found in bluegrass is highly attributable to genotypic differences.

The expcted gain in percent of the mean from selection of the superior 5% of the entries was computed on each of the characters studied. These values ranged from 21% for sod spread to 59% for total spread. Both values indicate that significant improvement can be made just by selection of the superior individuals.

The last analyses were the determination of intercharacter correlation coefficients, a statistic which allows us to determine, which, if any, characters tend to be associated in a non-random manner. The following characters were found to be significantly correlated with one another:

1. Narrow leaf angle with narrow leaf with.
2. Total spread with rust resistance
3. Wide leaf angle with prostrate growth habit
4. Extensive sod spread with prostrate growth habit

These associations indicate that effective, simultaneous selection for several of the characters studied would be possible.

In conclusion, sufficient genetopic variance exists to allow significant progress by selection for the characters studied. Slowly, such progress shall provide new varieties for your use.

- - - - - - - - - - - - - - - - -

GOOD SEED OR VEGETATIVE VARIETIES

Ben Warren, Warren's Turf Nursery
Palos Park, Illinois

There have been times when it seemed to me that we would be better off to have complete control of our planting stock. There is nothing more discouraging than to find serious contamination in a clean field after much effort in bringing a crop to near salable condition.

Some improvement has developed in seed quality in the past several years. The reputable seed companies offer seed free of Poa annua and bent. The accuracy of these claims are subject to question as there has been no change in the methods used in determining the presence or absence of contaminants. Laboratory analysis is the backing for such statements and in most cases is reliable, but this reliability is not 100%.

Knowledge of location in which the seed is grown and processed can be a help in avoiding contamination. Bluegrass is marketed from moist areas in which bent and Poa annua occur as naturalized plants. The chance of occurrence of these in seed fields is much greater than in dryer areas. Locations where bent seed is processed can be a

source of trouble when bluegrass is processed in the same plant. This condition would have to become very much more serious than it is for any of us to consider vegetative planting of any commercial bluegrass strains on the market today. This method would, of course, eliminate any outside source as a cause for contamination, but maintaining a clean and genetically true source of planting meterial would be no small task.

Those of us in the north that grow bent or Zoysia have some experience in vegetative planting on rather small acreage. The southern growers have demonstrated that this method is practical on a large scale. It is a practical method if there are sufficiently good reasons for doing so.

Before discussing the reasons for vegetative planting of bluegrass, it might be well to point out reasons for not going this route. Cost of planting is considerably higher than seeding, and the much greater time per acre involved would make timing of plantings difficult. Growing uniform blends would be very difficult, if not impossible. There are several conditions, some practical and others somewhat hypothetical which would warrant this method of planting.

We have, at present, about ten acres of bluegrass that have been established without seed. These are experimentals which rate high in our plot evaluation work, that we have increased so as to have material for further testing under practical use. Increasing in this manner enables us to accumulate much information prior to going into extensive seed production if seed propagation is possible. Two of the varieties that are performing well are at least 50% sexual, which means that it may never be possible to grow these from seed.

Lack of apomixis in a superior strain is an illustration of a situation which could make vegetative increase a widespread practice. We are seeing some selections, which are apomitic, but are such poor seed yielders that it is questionable whether seed production would be practical.

In this method of planting we have an advantage in weed control. The plant material used is mature and better able to tolerate herbicides than are germinating seedlings. This is of interest in spring and summer planting when annual weeds cause such serious competition. Fields planted in this manner, if handled carefully when removing sod, may be allowed to regrow with assurance of succeeding crops being relatively true. Most bluegrass strains considered apomictic have a percentage of off-types. Some of these are more vigorous than the parent and in regrowing tend to develop patches of dissimilar grasses.

We have tried several methods of planting, but still have plenty to learn. The various broadcast means that have been satisfactory with the stoloniferous bents have not produced as good results with bluegrass rhizomes. We, at present, are now planting with a transplanting machine, which uses several laborers,but, intend to continue experimenting.

- - - - - - - - - - - - - - - -

SALES AND USE OF ZOYSIA

R. P. Freeborg, Consultant-Agronomist,
Link's Nursery, St. Louis, Missouri

In the sales and uses of Meyer zoysia grass there are two distinct markets; the homeowner market, and the large volume market. The latter includes athletic fields, golf courses and large estates. For each market different sales and planting techniques are used. Local interest in Zoysia has taken many years to develop. We have had Zoysia grass in St. Louis since early 1940, but only in the last three hears has the homeowner really begun to accept it.

The homeowner, or primarily retail market, is reached through advertising on radio and in local newspapers, as well as through articles on the maintenance and uses of Zoysia grass, which are published in local papers and garden newsletters. We prepare and distribute literature concerning Zoysia grass performance, planting procedures and maintenance, and in addition we are available to speak to garden clubs and to participate in city and county sponsored turf field days.

Zoysia grass planting material available to the homeowner includes: 2-3/8" plugs; sod in 3 sq. ft. sections; and sprigs from shredded sod. Use of the latter by the non-professional is discouraged. The 2" plug is preferred, because it is easy for the homeowner to plant, and will yield better results with little loss.

We encourage sales of the plugs by making rental pluggers available to the customer and by offering price discounts as quantity purchases increase. By saving and submitting sales slips as he makes additional purchases, the customer realizes a reduced cost per plug.

In St. Louis the performance of Meyer zoysia grass in adapted areas, such as open, sunny locations, has been superior to anything else. It is widely accepted because after an initial establishment period it is relatively maintenance-free. There is no insect damage and no disease.

As turf cover is realize, fertility requirements are a minimum:

1. 20 lbs. - 30 lbs./1,000 sq.ft. 10-6-4, part organic, in spring to force growth and early greenup.
2. 1 - 2 lbs. Urea/1,000 sq.ft. as desired to deepen green color in summer.
3. Fall feeding with 10-6-4 at 20 lbs./1,000 sq.ft. will prolong green color and encourage earlier spring recovery.

Maximum management requirements are in spring. This includes thinning, close cutting (1/2"), and fertilizing with balanced fertilizer. After this, the major management program consists primarily of mowing no more than 2 times a week and no less than once each week.

A good deal of our early work with Zoysia has been in the golf course market and other large areas, such as athletic fields where we feel it will do a better job. We have experimented with fairway planting of Zoysia on several golf courses in the St. Louis area.

Planting procedures have included small triangular pluts, 2" sod strips on 12" centers, and 2" plugs on 1 foot centers. We cut the triangular pluts with a Rogers fairway slicer with blades were 1-1/2" to 2". The area is triple-cut, leaving small, triangular plugs cut at a depth of about 1-1/2". This area is then stripped to

a depth of about 1" with either a sod cutter, or a bucket on the front end of a tractor.

We plant the triangular plugs in slits made by a Link's Sprig Planter with a 1-3/4" slicing blade. Care is taken not to make the slit too eeep because Zoysia leaves require sunlight. This procedure has been used at the Algonquin Country Club without interrupting play on the course. Grass planted by the Link's Sprig Planter on approximately 16" centers requires about three years to become well-established.

We have also used the Bray Planter after having modified it to include a wider slicing blade that will slit rather than tear the soil. Sod strips are placed in the hopper of planter, shredded and fed to the planting unit as sprigs. We get better coverage from the same amount of planting material with the Bray Planter, but it must be pointed out that with sprig planting, moisture is much more crucial factor than with plug planting.

Sprigs planted with the Bray Planter on 12" center will probably take about 2 years or better to give good turf. We have not followed this program long enough to determine the best rates of planting, or length of time from planting to good turf cover.

The procedures involving use of the Bray Planter and Link's Sprig Planter are especially suited to the planting of golf courses because they do not interfere with play. There is, however, another method which we have used on other area such as athletic fields and sod nursery establishment. It consists of spreading the small triangular plugs either by hand or with a manure spreader over a previously prepared planting bed.

This procedure was employed recently on the football field of Maplewood High School in the St. Louis area. The field was subsoiled to break severe compaction. The next step was to roto-till, harrow and drag the soil with an earth scraper to establish a finish grade. We then planned to spread Zoysia over the area, one section at a time, to permit immediate watering.

At first we tried spreading with a blower-type spreader. This proved unsatisfactory. Because of the action of the hammers and the blower, most of the soil was removed from the plugs. This, as well as the blowing, encouraged undesirable, rapid drying of the Zoysia plugs. We finally decided to spread the plugs by hand, after which we tilled them in lightly with a Rogers 548 tiller-roller assembly. The last step was to roll and water the area.

Our nursery was planted in approximately the same manner, except for one minor change. This involved the use of a manure spreader instead of planting the plugs by hand. When using the manure spreader, we found it necessary to disengage the auger and use only the conveyors to throw the planting material. Zoysia planted as triangular plugs at about 6 bushels per 1,000 sq.ft., spread either by hand or by a manure spreader, will produce sod in about 1-1/2 years to two years at the most.

We recommend watering immediately following the planting of Zoysia. Frequently Zoysia grass has been lost because of a lapse in time between planting and watering. It is also extremely important that moisture be available until the grass has shown signs of recovering from transplanting. To reduce extreme, rapid loss of moisture, it is advisable to plant Zoysia on a cloudy day, late in the day, or even at night.

One should avoid fertilizing until the Zoysia has recovered from transplanting, and is ready to respond to fertilization. At that time an application of a balanced fertilizer, such as 10-6-4, should be applied at 20 to 30 lbs. per 1,000 sq.ft. This should be followed with applications approximately every 2 - 3 weeks of nitrogen, such as Urea, at about 40 - 80 lbs/acre and watered in. Weed controls are also necessary.

This can be accomplished either with the post-emergent AMA with some 2,4-D added, or with a pre-emergent such as Pre-San, or Tupersan, as soon as possible after planting. It is essential that some kind of weed control be established to reduce severe weed competition.

With the Midwest zoysia grass now on the market, we are anticipating better results, especially in larger athletic areas. At present, we are recommending blends of Zoysias and Bluegrasses. This, for example, is our current recommendation for turf in the new Downtown Stadium in St. Louis. We feel that such a heavily used athletic field will give superior service if established with blends of Zoysia and bluegrass and maintained with good soil blends, controlled irrigation, electric soil heating cables, and the improved grades of fertilizer now available.

Past experience and success with Zoysia has so far justified our high hopes for its future in the St. Louis area.

- - - - - - - - - - - - - - - -

MIDWEST ZOYSIA - SECOND REPORT

Dr. W. H. Daniel, Turf Specialist, Dept. of Agronomy
Purdue University

Zoysia is a relatively new grass compared to many other turfgrasses. It was first used in turf work after 1940 and released as a variety in 1950. Meyer has become rather widely distributed since that time in its adapted zone. In the more southern areas Emerald and Matrella have been distributed.

After ten years of research, Purdue University released a coarser, more open, faster-spreading Zoysia called Midwest. As with other crops, it is released through the Agricultural Alumni Seed Improvement Association, 2336 Northwestern, West Lafayette, Indiana. In 1963 approximately 50 purchases were made; in 1964 approximately 40. These went to nurseries, golf courses, individuals - no requests were turned down.

In 1965 ample foundation material is available from the above organization. Midwest Turf leaflet No. 10, "How Does Zoysia Look for Midwestern Lawns - fourth revision," available upon request from W. H. Daniel, Department of Agronomy, Purdue University, describes both Meyer and Midwest, and gives current known sources in the Midwest area. Supplies from nurseries should be available for the first time during 1965.

Based on our research at Purdue, I feel Midwest zoysia can be blended with blugrass, and with adjustments in the height of cut, fertilization and vertical mowing, a partial blend of these two species can be maintained.

- - - - - - - - - - - - - - - -

PURDUE STADIUM PROGRESS REPORT

Dr. W. H. Daniel, Turf Specialist, Dept. of Agronomy
Purdue University

The Purdue statium was first built in 1924. The field was extensively revised in 1948. At that time it was sprigged with U-3 Bermuda, overseeded with Merion bluegrass and Kentucky 31 tall fescue. The Bermuda was killed except in one small area where it persited for ten years. The tall fescue failed under high fertility and good management, so Merion bluegrass made the entire turf.

In 1961 extensive modification was accomplished to rebuild the rootzone and improve the porosity. During this renovation vertical slits filled with calcined clay were used to increase surface water removal. This was reported earlier, in the 1963 Proceedings.

During the winter of 1963 the field was lowered 8 feet, and during the spring and summer of 1964 the field was re-established.

The subsoil is a heavy, silty clay with no aggregation. Tiles were cut into this on 30 feet intervals. Gravel was placed around the tile and up to the surface of the subgrade; then the gravel was capped with 2"of sand. Above the subgrade 6" of soil was placed, then subsoiled and loosened; then a second 6 inches of soil was placed, which was also subsoiled and loosened; then 1,000 lbs. of 16-8-8 fertilizer, 3/4" of calcined clay (80 tons on 80,000 sq.ft.) plus 1" of loose peat (300 cu.yds.) wax mixed into the top 3". After leveling and heavy watering to settle soil, the field was sodded; the field itself being completed by July 2, and the perimeter sodded by August 1.

It was readily observed that water penetration was inadequate; therefore, we used vertical slits 1/2" wide and 10" deep to improve water penetration. Currently the soils used have proved so heavy that water penetration is not fast enough, and additional work is needed to remove surface water. This will be accomplished by making a narrow trench above each tile line, then filling this with calcined clay and sand; then resod. In my opinion on athletic fields the priority of conditions are:

1. No surface water at any time - must get through soil
2. Stable soils for uniformity - so stable underfoot
3. Grass cover is desired, but not necessary.

- - - - - - - - - - - - - - - - - -

TURF RESEARCH

Dr. W. H. Daniel

It has been the aim of the turf research program at Purdue University to work closely with all ideas and products possible towards turf improvement. Much has been said on the cooperation of institution with industry. I can assure you we have tried to remain alert and have good contact and close coordination with company representatives. Nebertheless, the intent of our work has been to work towards problem solving, using company products, when applicable, as a means toward that end.

Currently we are testing wilt reducers from five companies to see if wilting can be reduced on putting greens during hot, summer days.

We are also checking TIBA, an anti-auxin, to observe its effects on roots under stress of high nitrogen and close mowing.

Our work with calcined clays, in providing more porous rootzones, continues after five years.

Our greatest current effort is in bluegrass selection. Reports of graduate students, Lobenstein, Melkerson and Berry, have given you information on this work. Now we are looking for two types: those that could be closely mowed and have good disease resistance; also those that are vigorous and aggressive, have maximum wear tolerance.

We are also continuing our research on trying to selectively kill bentgrass, tall fescue, or nimblewill in bluegrass turf. Currently potassium azide looks encouraging.

Always we keep abreast of the crabgrass control materials and the possible expansion of their uses for Poa annua control, nimblewill control, other selective features.

We count on all possible coming to the Field Days, which are scheduled August 15; repeated August 16, 1965.

- - - - - - - - - - - - - - - - -

EXPERIENCE WITH GLASS MAT ON NEW SEEDING

Gordon Duguid, Supt., Big Springs C. C.,
Louisville, Kentucky

During the fall of 1964, while in the process of relocating and completely rebuilding three greens at Big Springs C., I had the opportunity to try and test glass mat on one of the greens. While contemplating the use of glass mat, I talked with men from the State of Kentucky, who have used the material as seed cover on steep slopes. They were having trouble with washes and had been most successful with the use of glass mat. Thus, the decision to try this new method on the last green to be rebuilt, which was #17.

The 17th green was built with 8,000 sq.ft. of putting surface, and an additional 1,000 sq. ft. of collar. In accordance with our building plans, a manually controlled, automatic perimeter watering system was installed around the green. I believe this to be a great advantage when using glass mat, or any other material, as it was not necessary to walk on the green until the mat was taken up.

On October 24 the green was prepared by applying 30 lbs. of 10-6-4 with UF; then .75 lb. of Penncross creeping bentgrass seed per 1,000 sq.ft. was applied. This was .25 lb. heavier than we used on the other two greens, for because of the lateness it seemed wiser to seed a little heavier. After a light raking and rolling, the green was sprayed with a wetting agent, using 8 oz. of material with 8 gals. of water per 1,000 sq.ft. The green was then completely covered, including the collar, with glass mat.

The glass mat is a weaved fiber glass, green in color, which was at the time available only in rolls 3/8" thick. Believing this too thick to suit our purpose, we divided the mat in half. This was done very simply by three men as the mat is manufactured in layers. These split sections 85 ft. long and 5 ft. wide were laid side by side across the green and collar. They were then held in place by using #9 wire cut 1 ft. long and bent into a U shape. These hoops were put through the mat and into the soil, three on the ends and four along each side. This proved most successful as the mat stayed in place, even with heavy winds.

The three mornings following completion of the green, white frost was quite heavy. By turning on the sprinklers, for three minutes, this was quickly dissipated. The green was watered once more during the day, for three minutes, and as long as the mat was in place it never dried out. By the afternoon of the fourth day, germination of the seed was visable to the eye. The temperature during this four-day period ranged from a high of 73° to a low of 27°. The temperature under the mat as checked during the day and four times at night, and it never dropped below 62°.

After ten days, on November 3, we found it necessary to remove the mat to enable us to cut the green. As you can see in the slide, the grass had reached a height of approximately 3/4". This was done simply by removing the metal hoops and re-rolling the mat and then storing it away for future use. The green was cut and lightly rolled following removal of the mat. Before the green stopped growing, it was cut three additional times, and thus far has come through the winter in good shape.

The second opportunity to use glass mat came during the last week in November when we received 1-6/10" of rain. This caused a lot of washing on a hill in back of #6 green. As soon as it was possible, the washes were re-filled, then the entire area was again fertilized, seeded with a 70% - 30% mixture of Kentucky blue and ryegrasses, sprayed with wetting agent and covered with glass mat. Since then the grass has germinated and completely grown through the mat, and even with additional heavy rains there has been no evidence of washing. We intend to leave the mat in place and continue to observe its effects on grass conditions and its ability to help retain moisture.

Glass mat, in place on a green, gives a very surprising effect, because of its color. During the ten days #17 was covered with mat, I received many calls from people who had watched the building progress, wanting to know the source of that <u>instant grass</u>.

There has been a change made in the manufacturing of glass mat during the winter, and it is now available in 3/16" thickness which eliminates the necessity for splitting the mat. It is also available in two lengths, 85 ft. and 250 ft., and has a standard width of 5 ft.

I intend to continue my work with glass mat in the spring and again next fall when we will rebuild three more greens.

- - - - - - - - - - - - - - - - -

MULCHES IN TURF ESTABLISHMENT

C. O. Finn, Finn Equipment Company
Cincinnati, Ohio

The acceptance in the use of mulch for the establishment of turf has reached an all time high in erosion control by living turf. You gentlemen are faimilar with the use of mulch; however, too few of us have understood just what mulch does in relation to the germination and the root growth of seedlings.

Mulch

A. Dissipates the kenetic energy of falling raindrops so -
   1. Reduces crusting and surface sealing
   2. Increases infiltration
   3. Reduces run-off
   4. Increases supply of moisture in soil
   5. Reduces erosion and soil displacement

B. Holds seed in place until germination
   1. Reduces stress on young root system
   2. Permits seedlings to better survive adversity

C. Reduces drouth stress
   1. Less surface evaporation
   2. Less complete drying at surface
   3. Slower surface drying

D. Modifies soil temperature
   1. Reduces freeze and thaw - by insulation
   2. Reduces high temperatures by shading
   3. Reduces low temperatures by insulation
   4. Modifies daily variation

E. Mulch favors the growth of bacteria, micro-organisms and insects so necessary for plant life.

F. Mulch cuts to a minimum the necessity for soil preparation

Starting with vegetative mulches, straw and hay are the most widely used. Using baled straw, 1 - 1/2 to 2 tons per acre, is usually spread unless there are special problems. The mulch spreading machines used today consist of a blower, a feeder, and a beater which breaks up the bales and blows the straw over the area to be covered. Uniform application is important. Thus, the use of good clean straw is to be preferred over wet, rotted, lumpy materials. This will produce more uniform growth. Clean straw usually has fewer weed seed present.

Holding straw or hay in place is done with the application of a small amount of water soluble asphalt emulsion. Seventy-five to 150 gals. per acre does a good job of holding the straw in place until germination and growth have started. In climates where prolonged drouth can be expected before seed germination, the straw mulch is usually pressed into the seed bed with a compactor, or disk. With straw mulch areas covered even on the hardest, driest slopes, insect life will be present after a few weeks. This proves the need of the micro-organisms to condition the soil for rapid growth. The use of Mulching and HydroSeeding is practiced on Interstate Highways in 45 of the 50 states.

During the past few years, the use of wood cellulose fiber has found its place in the Turf Establihsment field. This fiber is produced by the paper making industry, which is dried and pressed into handy packages. The paper fiber bale is put in the HydroSeeder where it is mixed to a slurry with seed and fertilizer. Approximately 1500 lbs./A. of wood fiber is used on an average mulching job. With the use of the HydroSeeder, seeding, fertilizing and mulching are accomplished with one operation. This method produces a mulch that has fair holding power and does retain the moisture in the soil.

A wide variety of other materials are now being machine applied either hydraulically, or in the Mulch Spreader. Their use is usually on a local basis where the transportation is not a factor. A few of these materials are corncobs, sawdust, peanut hulls, coffee grounds, composts from wood products, pine needles, as well as sugar cane bagasse. Most of these can be applied with the Mulch Spreader for low cost coverage.

Water soluble Asphalt Emulsion is also being used in Turf Establishment. This material is being spread over an area after it has been HydroSeeded with water, seed and fertilizer. The soil is wet to a depth of approximately 1", and from 400 to 800 gals. of non-toxic asphalt spread to make a crust on the surface. One of the factors in this method is that the asphalt lifts off during growth, leaving the soil exposed to erosion. We trust that these remarks will encourage more people to experiment with the use of mulch on any Turf Establishment work.

- - - - - - - - - - - - - - - -

HYDROSEEDING TURF AREAS OVER THE WORLD

C. O. Finn, Finn Equipment Company
Cincinnati, Ohio

Perhaps at the start we had better define HYDROSEEDING to find out what it is. HYDROSEEDING is a method where the seed, fertilizer and other nutrients are mixed with water and this slurry is spread under pressure through a nozzle over the area to be seeded. This method has been widely accepted as an important factor in turf establishment and erosion control work, as well as for decorative turf seeding.

The advantages of the HYDROSEEDING method appear to be these:

1. The seed and fertilizer are spread in one operation. This makes a fast method to take advantage of moisture and weather conditions.

2. We get faster germination and growth due, we feel, to the nutrients in the fertilizer made available in a soluble form for the seed to use as it germinates and establishes root growth.

3. The HYDROSEEDER can spread a seed mix slurry to a distance of over 150 ft. without traveling over the seed bed.

4. HYDROSEEDING minimizes soil preparation, and, when mulch is used, a large amount of gamble is taken from the planting.

The use of large grading equipment has caused a need for quick establishment of turf for the control of erosion both in the United States and in foreign countries.

Each one of these larger jobs presents problems. It has been my privilege to visit a number of countries installing HYDROSEEDING and MULCHING equipment and I cannot help but be enthusiastic over the results.

In GREAT SMOKY MOUNTAINS NATIONAL PARK, east of New Found Gap on State Route #70 going to Asheville, the grade was cut through virgin territory with high cuts and steep fills. Low soil fertility and high altitudes were also factors. The seeding work had to follow grading closely to get a turf cover established quickly to control erosion. To reach some of the high cuts the HYDROSEEDER, in the lower right hand corner, mixes the slurry of seed and fertilizer, which is pumped through 250 ft. of hose. The top of the slope is approximately 100 ft. vertical from the roadway. They had good results at 4 weeks and at 6 weeks.

The people of Japan are dedicated horticulturists. Each of these chrysanthemum arrangements were grown on a single stem.

Our HYDROSEEDING work started on a large irrigation project. This area was HYDROSEEDED and asphalt emulsion was used as mulch. This equipment is now being used on a made land area at Hachirogata. The University of Kyota is conducting some very interesting experiments in erosion control work. I must admit that we did have some communication problems due to the language barrier.

Switzerland is a fantastic country. In agricultural know-how they rank high. Their verision of the HYDROSEEDER is quite old for the use of liquid manure is common. They are very proud that there is no unemployment in Switzerland, but they seem to have forgotten to measure how much a man should produce. Picture a 6 ft. drill starting on the north 40 in Indiana with a man leading the horse, one following the drill, and a third helper.

Our job was to do the impossible. To get turf established on this bank without the use of dungen and topsoil. HYDROSEEDING worked again. This is GRASS ON THE ROCKS in 6 weeks. Their roadway seeding specifications were changed to HYDROSEEDING and MULCHING only 3 weeks after this demonstration.

Turf establishment along the Trans-Canada Highway through Banff National Park presented some problems. With 90 days from frost to frost, excellent turf has been established by Mr. Walter Johnstone, Landscape Supervisor, on gravel slopes and fills, using HYDROSEEDING and MULCH. The new grass is quite attractive for the wildlife in the park. Incidentally, HYDROSEEDING is being used on this Highway from Nova Scotia to Vancouver. This Canadian National Railway job was even further north. It ran from Edmonton to Wainwright. The quipment was mounted on a work train and the slopes and fills were seeded from the tracks. One of our customers at Durban, South Africa, has just completed 40 miles using this method.

We spent a few days at the Hawaiian Village in Waikiki making wildlife studies. Land is so valuable in Hawaii that it is not sold. It is rented for 99 years. A new subdivision is being carved out of a mountain side. They have rain nearly every day which helps plant growth, but it also causes plenty of water damage.

Australia

Our first installation in the country down-under was at Yallern near Melbourne. This is a brown coal mine with a seam of coal running up 100 ft. thick. The clay overburden slopes when wet would run down covering the coal. Turf establishment cured this. We had good germination after only two weeks.

England

Perhaps some of you gentlemen met Mr. Francis Bellingham of Rochester, England, while at the Ohio Roadside Development Short Course last October. He is doing outstanding turf establishment work in England, Scotland and Ireland, especially on chalk cuts and fly ash. He is so enthused over this work that he came to the United States last fall to tell us what he has been doing.

Bethlehem Steel

After the success of turf establishment on ordinary areas, it is only natural that one would come along that was outstanding. Bethlehem Steel Company of Lebanon, Pennsylvania, had deposited sludge from steel making on this area for 50 years. This area was an eye sore and a hazard for the community. Mr. Jim Francis, Chief Forester for the Bethlehem Steel Company, had visions of getting turf established on this area. It looked impossible, even to us. The sludge was so unstable that the equipment was mounted on a stone boat and pulled with a tractor. At times as much as 850 ft. of hose was used to spread the seed, fertilizer and Turfiber over this rea. Here are the results.

In our travels, we have found that there is no end of problem areas that can be cured by living vegetation. This is a shot of a typical Interstate Highway Interchange. Areas such as this, as well as cut and fill slopes, are being mulched and seeded with our equipment. This makes the highway more beautiful and erosion is held under control.

Peabody Coal Mine

We are now engaged in experimental work on coal strip mine areas. This is the Peabody Coal Mine at Paradise, Kentucky. This shovel scoops up 105 cu. yds. of earth at one bite and leaves problem areas in its wake.

We are cooperating in the development of a low-cost method of seeding that may be of some help here. We call this glob seeding. With the HYDROSEEDER we are able to make globs consisting of wood fiber, fertilizer, nurse crop and tree seeds. These globs can be shot from the HYDROSEEDER at a distance of 150 ft. They are spread on about 3 ft. centers. We hope to get growth started that will multiply as time goes on. Here are some of the early results of these experiments.

A large amount of experimental and research work must be done in seed selection and preparation and in fertilizer requirements, as well as other materials to promote growth. If this can be made to work, it will open up an entirely new field in HYDROSEEDER work.

In closing, I do not want to fail to mention that the HYDROSEEDERS are being used more and more in fine turf establishment. This is one of our smaller HYDROSEEDERS, with the high floatation wheels, being used on a turf farm outside of Cincinnati. This same machine can be used for topdressing greens. 1500 lbs. of mixture can be uniformly spread in less than 20 minutes. This BANTAM HYDROSEEDER is one of two owned by the City of Cincinnati in their "Most Beautiful City" program.

- - - - - - - - - - - - - - - - -

SELLING MATERIALS TO HOMEOWNERS

George J. Koehler, Pres., Koehler Bros. Landscape Company,
Lafayette, Indiana

Turf is very important to our business. Being engaged in a combination Landscape, Garden Supply, and Nursery operation, means that we are very much in need of all of the business that turf creates for us. Our primary concern is to produce and maintain, or cause the customer to produce and maintain the best turff possible. If this happens, he will continue to favor us with his business. We will continue to thrive and grow, and everyone will be happy.

When we stop and think of the many items that we sell, or that we could sell, that are directly related to turf, it is sometimes difficult to comprehend. The growing of good turf has opened up to us an enormous amount of products to supply to Mr. Homeowner. If our customers had no lawn, they probably would not want shrubs, trees, patios, pools, or any of the other items that added together complete the landscape picture. A good lawn is the basis for a beautiful landscaped yard. We must have it before we proceed any further.

What are some of these products that go into, or on the lawn? First of all is the grass seed to produce the turf. We supply seeds in bulk, or in ready mixed formulas for the customer's convenience. Fertilizers are readily available in practically any formula that would be needed or wanted. A variety of soil conditioners are ready for those who desire to build up their soil. Some of these are peatmoss, vermiculite, agricultural gypsum, and good rich topsoil. Once the grass is growing vigorously, there are weedkillers, insecticides, fungicides, or combinations of these sometimes mixed with fertilizer to keep the lawn free of weeds, bugs, or diseases.

Of course, all of this lawn work could not be accomplished without the use of a variety of tools. This opens up another facet of the garden supply business that sometimes is a business in itself. Customers need rakes, shovels, holes, aerators, clippers, weeders, spades, sod lifters, mowers, and many other hand tools. To apply the many powdered ingredients, they cannot do without a spreader of some sort. Closely related to this come leaf carts, wagons, wheelbarrows, and leaf burners.

Then, the power equipment comes out in force. We have many types of power lawn mowders, edgers, sweepers, vacuums, aerators, powerakes, and others. To keep a lawn well-watered we have for Mr. Homeowner any number or style of sprinklers. He can get one that whirls, spins, waves, or creeps. He can also choose from a wide selection of nozzles to assist him in his task of keeping the turf wet. He must have hose to carry the water, and this we supply him also.

A beautiful lawn creates a desire to spend more time in the yard, and offers many exciting things to buy to enhance the usefulness of this open-air living-room. There are lawn games, lawn furniture, barbecues, and an endless number of items to supply to Mr. Homeowner.

What does Mr. Average Homeowner really want in a lawn? What does he know about a lawn? What does he get when he calls on us for his needs, and what does he do about it after he has it? We often tell our customers that they need only two things in order to have a good lawn - time and money. If they have enough money, they do not need the time, as they can turn the project over to us and we will create the good lawn for them. Most people want, of course, the impossible. They want a turf that will grow to two inches in height and stay that way, never needs fertilizing or watering, is insect and disease-free, and stays beautifully green the year 'round. If we could

come up with such a grass, our fortunes would be made.

The average customer knows very little about a lawn, or what it needs to thrive and grow. There are a few that have studied, read, asked questions, and experimented on their own. They know exactly what they want, and usually they do a good job. These are no problem to us, and as long as we provide them with the product they want, we have a happy customer. Most of the people who come to us for advice know very little about their lawns. They are completely open to suggestions, and will purchase according to our instructions. We find only a small part of these people are pre-sold on any given name brand. They can be swayed to buy whatever we believe will do them the best job.

In many cases we find it necessary to make a trip to the customer's home to study his particular problem. This may be true in building a new lawn, as well as looking over an established turf to determine its needs. These visits turn up many unusual conditions and circumstances, and we must be ready at all times with answer of some sort to satisfy the customer. We are not always 100% right, but if not, we go to any extent to find the solution to this particular problem. Most customers appreciate this extra effort, and reward us with their continuing business.

Mr. Average Homeowner drops by our store in the spring, discusses his lawn with us, and we proceed to sell him what we think will get him started to have the most beautiful lawn in the block that summer. He goes home all set to carry out this plan. We have armed him with the proper materials, and a reminder to return later in the season, or whenever he runs into unexpected troubles. However, even though his intentions are good, before the season is over, something has sidetracked him, and his lawn has met the same fate as the previous year.

He probably applied his first round of fertilizer, perhaps reseeded some of the bare spots, and maybe even applied some pre-emergence crabgrass killer. Then, when it began to get hot, he was too interested in fishing or golfing, or just plain loafing on his days off, to keep up his lawn. He was too busy to notice that the weeds were taking over in spots, the hot sun had burned his grass where he cut it too short, or it was too dry and needed wateringg badly. Finally, when his lawn looks miserable, he frantically calls us, and wants to know what is wrong. Upon questioning, he will usually hesitate to admit that he was negligent in his treatment of the grass, and wants us to undo all of the damage with one quick application of something. Or, perhaps in some cases, Mr. Average Homeowner will just give up on his lawn when it becomes hot and dry, and attack it again the next spring.

The above type person is probably more the rule than the exception. These are the people we set our sights on and try to convince that they should stick with their lawn the year 'round. It seems that once we persuade them to complete a year 'round program on their lawn, they realize how much better results they have, and that it actually costs them less to maintain their lawn than it does to repair it every year. A happy lawn customer is the best customer we have, as they are continuously calling on us when they need items that are closely related.

We encounter many problems in selling lawn materials to homeowners. Most people who have just built a new home are short of money. They have found that everything about the house cost a bit more than they figured. Now that they have reached the outside there is nothing left. But, they do need a lawn, and it goes in even if it is

done very haphazardly and at little expense. This usually gets them off to a bad start, and causes later problems. In many cases, a poor seed mixture is used, little or no fertilizer is used, the grading is hit or miss, and a poor stand of grass results. When these folks come to us, it is sometimes just as costly as it would have been if we had done the job for them in the first place. Here again are the people we must try to reach before they get off on the wrong foot.

Price is also a major factor in the competition we receive from supermarkets, chain stores, discount houses, drug stores, 5 and 10 cent stores, and others. These outlets are interested only in turning a fast dollar at a small margin, and are not a good source of information and service for the homeowner. This we can combat only with the fact that we supply this professional advice and service. But with many, price is the only criteria of buying, and we lost these people.

We bump our heads into many problems in handling new lawns. In many cases it seems that everyone is against the landscaper when he gets to a yard. The contractor has bulldozed all the good earth away, compacted the soil so it is like concrete, left the downspouts on the house to spill out into the lawn and cut furrows during a heavy rain, and covered all sorts of debris just under the surface rather than gather it and remove it from the premises. The painters wash out their paint buckets on newly seeded areas, and the postman and other delivery men walk paths across the yard. Then there is always a dog and the neighbor's kids who tear up the freshly graded slopes.

Probably our biggest single problem in selling to Mr. Homeowner is our help. We never have enough employees to get the job done. We are in the process now of trying to build a better image of our business in order to get it on a higher plane. Then, perhaps, we can attract better caliber people and be able to pay them a better wage than our business has been able to afford in the past.

Selling lawn materials to homeowners is an interesting part of our business. We believe it is going to be an ever-increasing part. Some of the problems we have now we hope to eliminate, but many will go on year after year. We will have to learn new ways to cope with them. Mr. Homeowner is our entire future. He is a wonderful person, sometimes tricky and sometimes troublesome. But, we love him, and we hope he will continue to allow us to help him build a better and more beautiful world.

- - - - - - - - - - - - - - - - -

TABLE OF TWENTY-FIVE MOST FREQUENTLY USED PARLIAMENTARY MOTIONS*

Dr. B. R. Kendall, Speech Department,
Purdue University

*Based on Robert's Rules of Order;
Arranged by Leroy T. Laase

MOTIONS ------ and ------- PURPOSE		NEED A SECOND	AMEND-ABLE	DEBAT-ABLE		MAY INTERRUPT A SPEAKER
IV. Privileged Motions (arranged from bottom to top in order of precedence)						
25. Adjourn to specific time	to arrange time of next meeting	yes	yes	no	majority	no
24. Adjourn	to dismiss the meeting	yes	no	no	majority	no
23. Take a recess - to dismiss	for a specific length of time	yes	yes	no	majority	no
22. Raise a question of privilege	to make a request during debate	no	no	no	decision of chair	yes
21. Make a matter of special order	to force consideration of a specified time	yes	yes	yes	2/3	no
20. Call for the orders of the day	to force consideration of a postponed motion	no	no	no	decision of chair	yes
III. Incidental Motions (no order of precedence)						
19 To appeal a decision of the chair	to correct or reverse chairman	yes	no	yes	majority	yes
18. To call for a division of the house	to correct or reverse chairman	no	no	no	majority if chair desires	yes
17. To raise a point of order	to correct a parliamentary error	no	no	no	decision of chair	yes
16. To object to consideration	to suppress action	no	no	no	2/3	yes
15. To divide motion	to modify motion	yes	yes	no	majority	no
14. To modify or withdraw a motion	to modify a motion	no	no	no	majority or unanimous consent	no
13. To suspend rules	to take action contrary to standing rules	yes	no	no	2/3	no
II. Subsidiary Motions (arranged from bottom to top in order of precedence)						
12. To rescind	to repeal	yes	yes	yes	majority with notice 2/3 without notice	no
11. To reconsider	to consider again	yes	no	yes	majority	yes
10. To take from table	to consider again	yes	no	no	majority	no
9. To lay on the table	to defer action	yes	no	no	majority	no
8. To call for the previous question	to force into immediate vote	yes	no	no	2/3	no
7. To limit or extend limits of debate	to modify freedom of debate	yes	yes	no	2/3	no
6. To postpone to a certain time	to defer action	yes	yes	yes	majority	no
5. To refer to a committee	to modify a motion	yes	yes	yes	majority	no
4. To amend an amendment	to modify a motion	yes	no	yes	majority	no
3. To amend or substitute	to modify a motion	yes	yes	yes	majority	no
2. To postpone indefinitely	to suppress action	yes	no	yes	majority	no
I. Principal Motion						
1. A main motion	to introduce busines	yes	yes	yes	majority	no

Midwest Turf
NEWS AND RESEARCH

No. 33 March 1965

DEPARTMENT OF AGRONOMY
PURDUE UNIVERSITY

Electrically Warmed Soils for Sport Turfs--Second Progress Report

J. R. Barrett, Jr., 1/ and W. H. Daniel 2/

Introduction

Cold season soil warming has become eligible for acceptance as a part of turf management programs. Heat applied to the root zone of bluegrass plants alters the natural temperatures in which the turf exists, thereby keeping the soil from freezing, promoting root growth and blade extension, keeping turf greener, and melting snow.

Investigations to determine the requirements for installation and management of electric soil-heating cable systems to maintain suitable turf conditions for sports activities during cold weather are being continued by the Purdue University Departments of Agronomy and Agricultural Engineering, and the Farm Electrification Research Branch, Agricultural Engineering Research Division, ARS, USDA. This research program is endorsed by the Indiana Electric Association.

Escritt's early work at the Sports Turf Institute, Bingley, England, has led to several electric heating installations in Britain. Everton Football Club was the first to install electric soil warming in their ground at Goodison Park. Edinburgh's Murrayfield rugby football ground was equipped with electric heating in 1959. Electric off-peak pitch warming is built into the Arsenal ground at Highbury. At least one stadium in Sweden has electric, and another has warm-water soil warming.

Prior Work at Purdue

From February 1962 through the 1962-63 winter, many factors were investigated to determine the potential of a research program and to gain information about energy-input relations to temperatures, cable performance, installation procedures, control systems and grass response. Earlier work was reported at the 1964 Midwest Regional Turf Conference and published as Midwest Turf News and Research Leaflet No. 28. The data were examined and used to plan an installation of test plots in the Purdue varsity football practice field.

Turf Heating in the Purdue Varsity Football Practice Field

Five plots, each 10 by 120 feet, separated by 10 feet of unheated area, were installed in August 1963. A general view of the area is shown in Figure 1.

1/ Agricultural Engineer, Purdue Dept. of Agr. Engr. and ARS, USDA.
2/ Turf Specialist, Purdue Department of Agronomy.

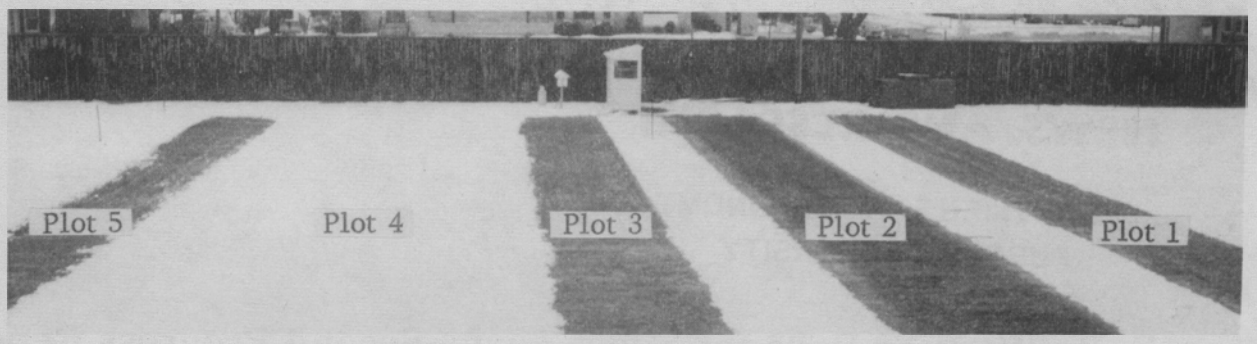


Figure 1. General view of electric heated turf plots installed August 1963.

Installation Procedure: Cables were placed under the existing turf using a cable-laying device made from a modified sub-soiling tool attached to the toolbar of an agricultural tractor. A rolling coulter sliced the sod in front of the device to prevent excessive tearing.

After laying the cable, the area was soaked with water and packed with a roller. The turf was smooth enough for practice immediately after rolling and was completely healed in 4 weeks.

Cables, Spacings and Power Densities: Polyvinyl chloride insulated, nylon jacketed, electric heating cables were laid according to the specifications given in Table 1.

Table 1. Cable spacings and power densities

Plot	Cable spacing at 6" depth	Power density Watts/sq/ft. at 240 V
1	15.0"	4.5
2	7.5"	9.0
3	7.5"	9.0
4	15.0"	4.5
5	7.5"	2.5

The locations of the plots are shown in Figure 2.

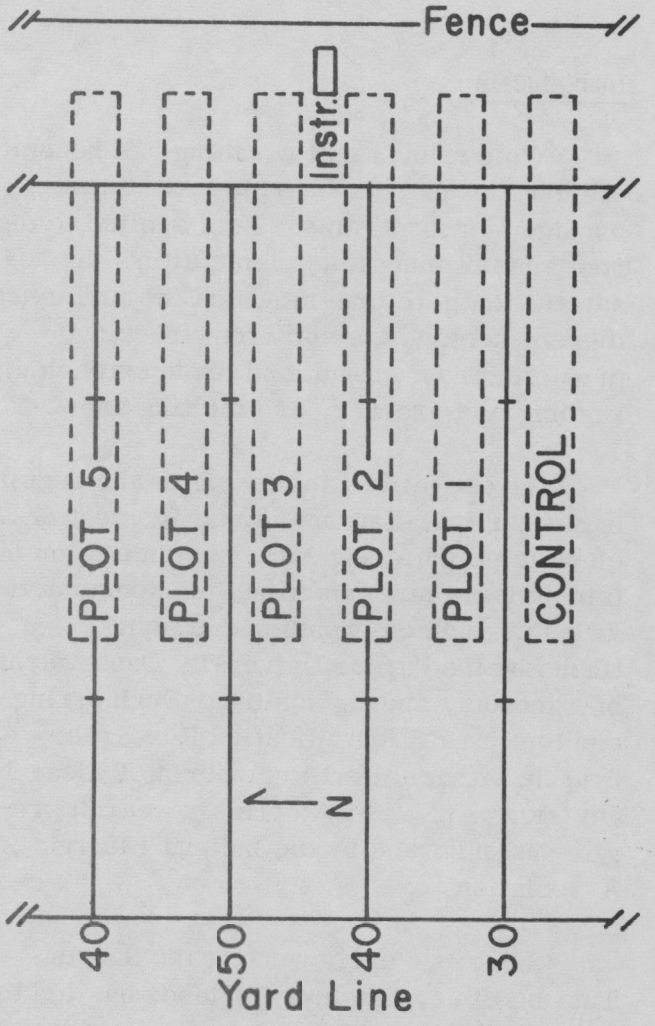


Figure 2. Plot layout, Purdue varsity football practice field.

Control Systems: Air temperature was found to be the best indicator of when heat should be applied. Temperatures in the soil defined the heat reserve and soil thermostats were used as limit switches to maintain the desired soil warmth. Use of time clocks allowed inclusion of off-peak electrical demand considerations.

Heat was applied to Plots 1 and 2 at any time the air temperature was less than 40°F. or the 1-inch soil temperature was less than

Table 2. Electric energy use data, 12/2/63 through 4/6/64

Plot	Power Density Watts/Sq. Ft.	Max. Time Plots Could Operate/Day Hours	Max. Time Plots Actually Operated/Season Percent
1	4.5	24.0	74
2	9.0	24.0	71
3	9.0	7.1	95
4	4.5	7.1	97
5	2.5	24.0	99

45°F. Heat was not applied when the 1-inch soil temperature was above 60°F., regardless of air temperature. Plots 3 and 4 had similar control systems except that heat could be applied only from 10 p.m. to 5 a.m. Plot 5 operated continuously. The test season lasted from November 6, 1963 through April 6, 1964, a period of 152 days.

Effects of Heat Treatments: The effectiveness of the heat treatments was evaluated considering electric energy used, temperatures, turf condition and turf growth.

The percent of time that heat was applied of the maximum possible from December 2, 1963 through April 6, 1964 is given in Table 2.

The average monthly temperatures for the heated plots and the control area are given in Table 3.

Table 3. Average soil temperature 1-inch deep at 8 a.m. in degrees F.

Plot	Dec.	Jan.	Feb.	Mar.
1	43	40	41	44
2	54	49	52	54
3	42	40	40	46
4	37	35	36	41
5	40	38	38	44
Control	34	32	32	37

Observations were made each day at 8 a.m. to determine the number of days that the turf medium was frozen from January 1 through March 31, 1964. Table 4 shows the number of days the plots were frozen during the 91-day period.

Table 4. Number of days turf medium was frozen, 1/1 through 3/31/64

Plot	Jan.	Feb.	Mar.	Total
1	4	0	0	4
2	0	0	0	0
3	8	1	0	9
4	10	7	2	19
5	11	1	0	12
Control	24	19	7	50

Table 5. 8 a.m. temperatures on January 29, 1964 in degrees F.

Depth	Plot 2	Plot 5	Control
0	37	31	29
1"	46	34	31
6"	61	40	35
1'	63	44	37
2'	61	45	40
3'	60	50	42

Shaded air temperature was 18°F.

Temperatures were taken to 3-foot depths in the control area, Plot 2 and Plot 5. Sample temperature readings during a cold period are listed in Table 5.

The surfaces of Plot 5 and the control were frozen and heat was being lost from the earth below, through the test zone, into the air above. However, in Plot 2 the cable had stopped the heat loss from the earth below.

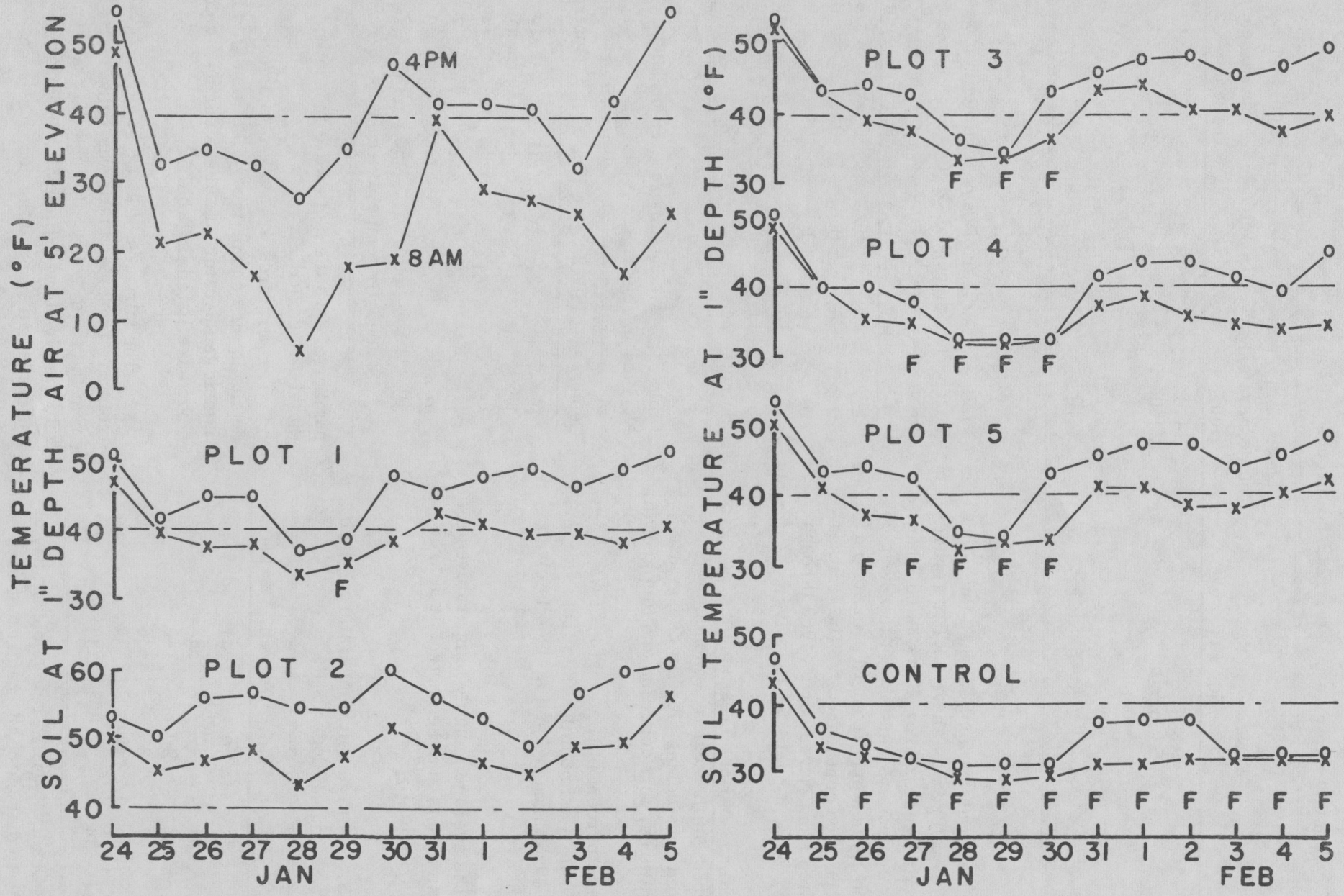
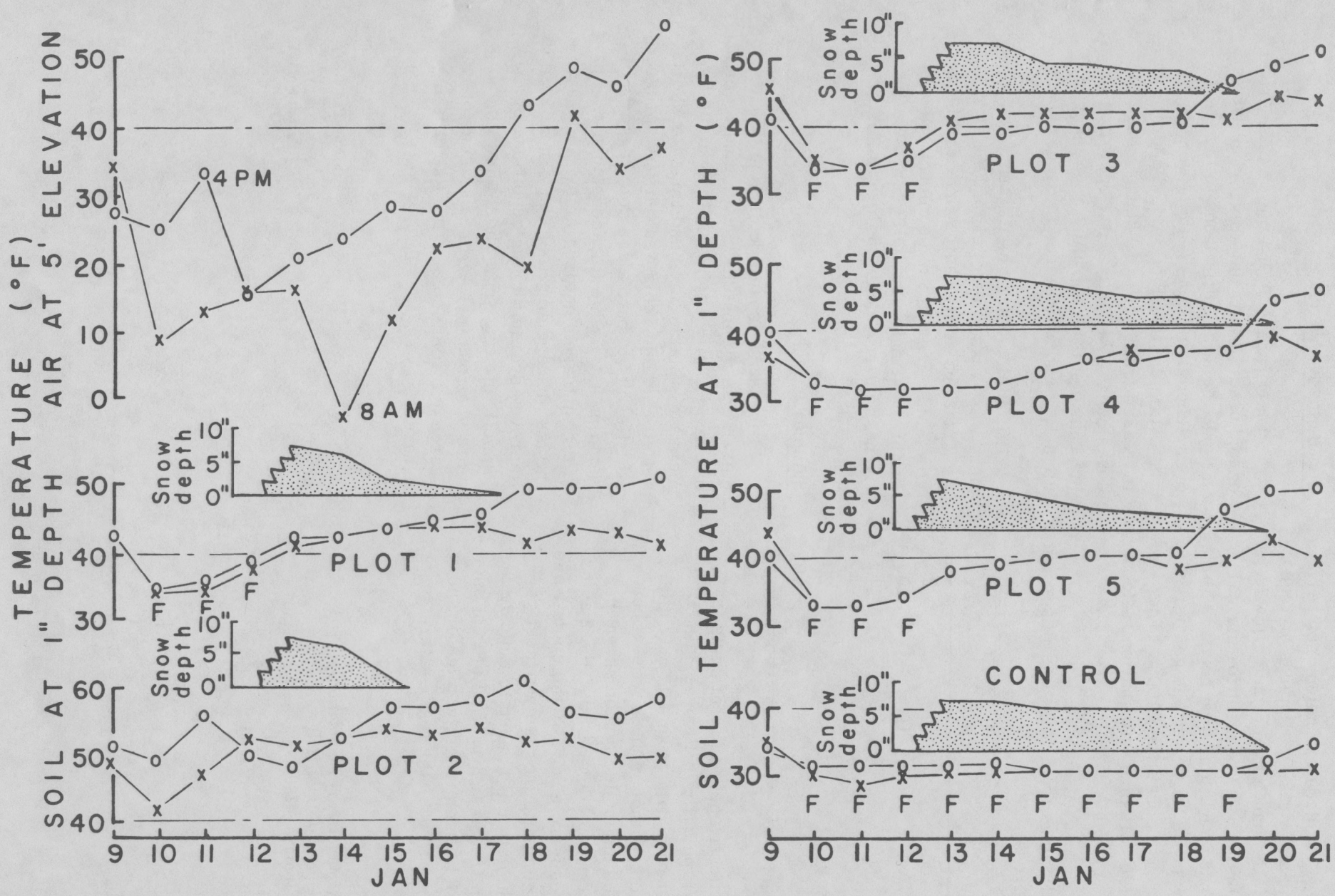


Figure 3. Graphical presentation of 8 a.m. (X) and 4 p.m. (0) temperatures during a period with no snow cover in January-February, 1964. F indicates that the turf was frozen at 8 a.m.



[18]

Figure 4. Graphical presentation of 8 a.m. (X) and 4 p.m. (0) temperatures during a period with snow cover in January 1964. F indicates that the turf was frozen at 8 a.m. Rate of snow removal is indicated by plots of snow depth.

Growth, or blade extension, comparisons were made by taking clippings at regular intervals, as snow cover would allow. Adequate moisture was present for normal growth without irrigation being needed. Table 6 gives growth data on a percentage basis with most growth considered 100%. The January 9, 1964 clipping information reflects early winter growth.

Table 6. Clippings from turf plots in percent of most vigorous, 1964

Plot	Jan. 9	Feb. 12	Mar. 6
1	100	70	30
2	90	100	100
3	60	30	10
4	60	20	10
5	95	30	20
Control	5	10	10

The effectiveness of treatments is presented graphically in Figures 3 and 4. Figure 3 contains data from a 13-day mid-winter period, without snow cover. Snow cover existed during the period shown in Figure 4. One a 24-hour basis, the 8 a.m. temperatures were generally the coldest and the 4 p.m. temperatures the warmest recorded. The letter F is used to indicate that the turf was frozen at 8 a.m. Rates of snow removal can be seen from the plots of snow depth interposed over the temperature graphs.

Continuing Research

On October 2, 1964 power was turned on and observations initiated for the 1964-65 season. Some modifications to the treatment schedule of Plots 3 and 4 were made. The maximum that Plot 3 could operate was increased from 7.1 to 10 hours a day. Plot 4 was set for 24-hour-a-day operation if the 1-inch soil temperature was under 60°F. Plots 1, 2 and 5 remained the same.

Complementary turf heating installations were made in the fall of 1964 at USDA field stations at St. Paul, Minn. and Beltsville, Md. Data are to be correlated with findings at Purdue and will show the effectiveness of treatments in three different climates.

Summary

Investigations to determine the requirements for installation and management of electric soil-heating cable systems to maintain suitable turf conditions for sports activities during cold weather have progressed. Results to date place cold season soil warming as eligible for acceptance as a part of turf management programs. Soil warming is a management tool that can be used to improve adverse playing conditions by thawing soil, melting snow and maintaining more vigorous turf. Three seasons of research are complete and the fourth is in progress.

Midwest Regional Turf Foundation
Purdue University, Lilly Hall
Lafayette, Indiana 47907