K. D. Payne

400

1950 ANNUAL CONFERENCE
MID-ATLANTIC
ASSOCIATION OF GREENKEEPERS

SPONSORED BY

ENTOMOLOGY DEPARTMENT
UNIVERSITY OF MARYLAND
DR. ERNEST N. CORY, DIRECTOR

Table of Contents

Compiled by:

WEST POINT LAWN PRODUCTS

West Point, Pennsylvania

FUNDAMENTAL ASPECTS OF THE SOIL AS A MEDIUM FOR TURF GROWTH

O. J. Noer, Agronomist
Milwaukee Sewerage Commission

Members of the Mid-Atlantic Greenkeepers Conference, I am happy to be here. This morning's program, as I understand it, is designed to correlate various soil factors with special regard to the troubles that so many experienced last summer. This afternoon at 2:30, practical discussions by Scott, Heckert and Watson will provide you with the meat. They will unburden and tell you how they do it. Then you can compare notes.

In this morning's newspaper I noticed a little squib from Sydney, Australia. Three spinsters anxious to improve their front lawn, helped themselves to some material dumped beside the road for repairs and top dressed the lawn with it. The results should be interesting. The top-dressing used was a 3 & 1 sand-cement mixture. I don't think that any of you have any qualms about the results. They will have a nicely paved lawn instead of a green one.

Soil for greens is uppermost in everybody's mind. Grau, myself and many others have stressed the soil, particularly its physical aspects as a medium for growth for many years. Unless the soil is right, anything we do is of little avail in a disastrous season such as the last one. With bad soil it is impossible to cope with adversity. In Milwaukee our overall average above temperature for the summer was 1000°. The hot weather started in June, as it did in most other places, and stayed with us right through August. We had really good bermuda weather rather than bluegrass and bent weather. That was true elsewhere.

Soil is not so much dirt, but a mixture of a solid, a liquid, and a gas. Each component is extremely important. The soil mass should be about 50% by volume. The other 50% should be voids; half occupied by air, and the other half by water. I like to think of soil as a world unto itself. It is teeming with a population very much like the world we live in. Sometimes it is overpopulated and there may be more races than there are of people on the earth. The occupants are soil bacteria, fungi, protozoa, Actinomycete, worms, and even animals. They and the living plant roots must have air. Without soil of the proper physical

condition it is impossible to have the kind of root systems that we all strive to attain.

During the summer of this year I think our laboratory received more soil samples than ever before. In almost every letter the question was raised, "What fertilizer can we use to give us a deeper root system?" Personally, I can't believe that everybody has been wrong so far as fertilizer practices are concerned. Shallow roots are due more to physical factors in the soil rather than to plant food deficiencies. Of course the important one is soil air. Other incidental factors include turf matting, localized drying, tree roots etc. Yet as I traveled the country last summer, my feeling was that soil compaction was responsible for shallow roots more than any other factor.

We have probably overlooked something very important from the standpoint of the air relationship in the soil. We have told you that the soil should have about 25% of air, but we never stressed the framework or structure of the soil and what it should be like. Many compacted soils contain enough air, but the pores are so fine and so small that they fail to move water. These are the capillary pores from which roots obtain water and soil nutrients. Larger non-capillary pores which are responsible for the rapid movement of surplus water down through the soil are needed also. Surplus water moves rapidly through the soil only when there are large pores present. If all the pores are small, surface forces on the soil particles hold the water and prevent the entrance of air into the soil.

I presume that the lowly earthworm did much to develop non-capillary passageways. I am not advocating a return to the earthworm era because I know the golfer will decide against you. The minute he sees earthworm casts on the green, he is going to tell you about it and you are going to do something or somebody else will take your place. That being the case, we are apt to see much more cultivation.

In hot weather when downpouring rains are frequent, power mowers promote soil compaction. They do not improve soil structure. This statement is not intended to advocate a return to hand mowers because I am sure the workmen will settle that question in short order. But power mowing is not the big time and money saver some think. It complicates the problem of maintaining a desirable physical soil relationship from the standpoint of solid matter, air and water.

On greens and tees it is possible to do something about soil texture. But on fairways, especially the sandy ones, little can be done to improve physical soil conditions by top dressing because of the huge expense due to the acreage involved. Heavier fairway soils can be improved by cultivation with the equipment now available.

With these few introductory remarks I shall use Kodachrome slides and then Fred Grau will discuss soil and water relationships. After that Marvin Ferguson will tell you about soil factors affecting the absorption and utilization of soil nutrients. I am sure he has something very worthwhile to tell you. At times this past summer I saw turf which was not able to utilize nutrients from the soil due to poor physical factors more than anything else. I presume and hope that he is going to discuss them.

Bill Glover will follow Ferguson and tell something about management and environment as they affect disease which to me is extremely important. I saw courses this year that had disease a plenty, yet right across the road the greens were not doing too badly. The difference was not due to a marked difference in soil but was due to better management more than anything else. Later in the day we will hear from Robert Scott, Riley Heckert and Oscar Fitts in place of Dick Watson who may have to leave. After Grau finishes I hope we will have time for a few questions and then a 5 minute recess.

This picture is a soil profile from a green at the Milwaukee Country Club. All the greens are more or less alike. The picture is not intended primarily to show you an ideal soil structure, although I have never seen too much trouble on the greens there. It shows the kind of top dressing used by three different greenkeepers. This is the Charlie Gardner era, or the sand era, when almost pure sand was used. After that Fred Haslow took over. He was a great believer in peat. You can see the black layer of peaty soil. The greens became so soft and spongy that the surfaces became objectionable to players. When Ted Booterbaugh took over, he used what to me is a more desirable mixture consisting of soil, enough sand, and not to exceed 20 percent of peat by volume.

This profile is from a green at Detroit. Notice the distinct sand layer. I presume 5 to 6 yards pure sand was applied on the green at one time. The sand layer caused considerable trouble during the time. It was

close to the surface. Fred Grau may tell you something about the experiments which were conducted at Purdue. Their findings explain why sand layers cause trouble in hot weather particularly if they are within an inch or two of the surface. The best soil for top dressing is a medium sandy loam with not to exceed 25 percent of organic matter by volume. It should have enough sand to insure rapid movement of water. There should be a little clay present to provide an exchange complex to hold and then release plant food. You cannot go far wrong with a mixture of that kind.

This low-lying green is in the Detroit area. The turf appears to have been scalded. To me it looked like one of those rare instances of iron deficiency aggravated by too much organic matter in the soil and too much rain. I got the man in charge to put a little iron sulfate (copperas) across half of the green. He reported two weeks later that the ferrous sulfate restored green color and stopped further loss of grass on that green. Of course, it didn't bring the dead grass back to life.

The next picture of a green in Saginaw was taken during July when temperatures were up in the low 100's every day. I don't have to tell you what happened here; localized dry spots developed around the edge and the grass was wilting. The man doing the mowing, instead of turning on the apron, was turning out on the fringe and, of course, the bruising action of the drum killed the wilting grass. I saw a number of similar examples in out-of-the-way places. In Washington and Baltimore you are accustomed to hot weather and would not think of twisting a power mower on wilting grass. The picture illustrates what pressure does to grass in hot weather when it is wilting badly.

Here is an example of excessive traffic and what it does to turf. I was in Ann Arbor, Michigan, in the fall of 1947 and noticed this regular pattern on the practice field. The band, 100 strong, practiced maneuvers on the area for ten days. One hour of marching back and forth each day for ten days was enough to cause the excessive wear on the field. The grass was not growing aggressively, nevertheless the picture shows graphically what mechanical wear does to grass.

This picture tells quite a story. It is on a green in Maine. I was there in early August when they were experiencing Washington, D. C. weather. The boys up there are not accustomed to weather of that kind. The greens were heavily matted and had many localized dry

spots on them. You can see the footprint damage caused by the pressure of the player walking across the wilting grass. That is why it might be better to forget about mowing when the grass on a green is wilting badly. It would be better to use a little water to restore grass leaves to a normal condition before putting too much pressure on the turf.

Now just a bit about fairways. This is an example of something given scant attention. It is injury caused by seepage water along a hillside slope. The picture shows seepage water coming out of the rocky side slope. Notice how poor the turf is in the wet area.

This example is near Montreal. It is spring injury on a fairway due to seepage. The next is a golf course in Kansas City where I have felt for a long time that the fertilizer being used on fairways was not doing too much good. I believed failure was caused by seepage coming out of these hills in the spring. When I spoke about the seepage to the officials, they told me that their fairways were never wet; they were always dry. I told them that fairways were dry when they played because they didn't come out during cool weather in the spring. Incidentally, there is Tom Mascaro. I decided to do something to convince club officials that I was right. I went on down to one of the other fairways. Holes were made with a post hole digger and they were checked for standing water in the afternoon and on the following morning. On the uppermost fairway we were able to put a hole down about 4 or 5 feet. At the intermediate slope, the hole was about three feet and on the lowest fairway, rock was encountered at 1½ feet. Within two hours the hole on the lowest fairway was full of water. On the side hill within two hours, we had water almost up to the top. Notice the crabgrass from the year before in the surrounding area.

This is a picture of the top slope where you saw Tom Mascaro. Within two hours there was approximately eight inches of water in the bottom of the hole. The next day the hole was completely filled. The next picture gives you some idea of the amount of water in the hole. Red Lambert, the man in charge, was never able to sell the membership on drainage to intercept the seepage. So I made a series of black and white pictures and mounted them on a 16x20 mount for him to put on the bulletin board in the club house. Within two weeks the members came to him and asked when he was going to put in the tile that was necessary to correct seepage. I personally don't believe any a-

mount of fertilizer or another type of grass would help. The first thing is to get physical soil conditions right, and then grass has a chance.

And now by way of introducing Fred, this picture taken in Philadelphia in the fall of 1947 shows green spots in the rough while everything else around them was brown from drought. I asked why the bluegrass was so good there, and so bad on each side of it. I was told that a green was rebuilt and the old one was kept in play until the new one was ready for play. Then the old one was used to fill some rather deep holes in the rough. Despite a drought of three to four weeks duration, the grass in these areas where the soil was much better both physically and in plant food content, the bluegrass was better and was able to resist the effects of drought. Where the soil was compact and low in plant food content, the bluegrass was brown.

Now I will call upon Dr. Grau to continue. He will discuss the relationship between soil and water.

-o-

SOIL AND WATER RELATIONSHIPS AND THEIR EFFECT UPON WATER USAGE

Fred V. Grau, Director
USGA Green Section

You will recall that just a year ago in this same room we started to discuss water shortages and the conservation of water. In our annual report of the Green Section Committee I mentioned the fact that our next big step would be to try to develop consciousness in the direction of saving more water, using less water, and thereby having better turf at lower costs with less disease. That dream is coming true. We have had a lot of observations and reports from all over the country to the effect that, where they have used less water than ever before and where they have improved the physical nature of the soil, they have had better turf and less disease. I think that is the cue that we should take from now on.

In the "Science Newsletter" a very famous scientist says, "The world is running out of water." That certainly is true. Our ground water supplies are drop-

ping, dropping, dropping. Nothing emphasizes it quite as much as the critical situation that has existed all summer in the New York area and still exists. The engineers up there say it is a permanent situation. The scientists say that the water situation is permanent and that it is world wide. So it behooves every one of us to preserve every drop of water that we can and to catch and save every drop of rainfall that we can. You have been reading about the terrific floods that they are having out in Indiana and Illinois and much of that is simply water runoff. It cannot get into the soil fast enough in spite of the fact that we have had an open winter.

Our objectives should be several. We want to modify our soils so that we can achieve maximum absorption. Get that water into the soil as quickly as possible so that the roots can make use of it. Try to achieve minimum runoff because water that runs off carries with it valuable nutrients. It can't help it. The nutrients are taken up in solution by the water and when the water runs off with it goes a part of your nutrients. Try to achieve minimum water usage. Most of us have used far too much water in an effort to grow better turf. We want extensive root development. I am going to point out to you something that highlights what we can do by improving the root systems. Of course, we want maximum aeration. Noer has always been a missionary from that standpoint.

I am going to take just two types of soils. There are so many that we can't discuss all of them. I want to point out to you some of the essential characteristics of these two types of soils. First the kind of soil that most of us have (clay) and second the kind of soil that we would like to have for growing grass (sandy loam).

Clay loam soil is one which will contain 20% to 50% of sand. It will contain 20% to 50% of silt. It will contain 20% to 30% of clay. That kind of soil will hold lots of moisture. It is the kind of soil that Noer was talking about that has a high pore space capacity but the pores are so fine that water runs through it with great difficulty because there is too much friction. You know if you have a half inch hose, you are going to have a lot of difficulty with that hose to get enough water through it to take care of the greens. But if you have an inch hose, you will get many times the amount of water because there is less friction. That is the best example I can think of.

In a sandy loam you will have 50% to 80% of sand, 0% to 50% of silt, and 0% to 20% of clay. 20% clay is the highest you can have in a sandy loam. We have always spoken of a sandy loam as a more or less ideal type of soil in which to grow specialized turf. A sieve analysis of the soil is easy to make. Any soils man can do this for you. The figure can be charted and you can tell if you have a sandy loam or a clay loam or any other type of soil. We are going to see more of that type of thing so that we know the kind of soil with which we are dealing.

A clay loam soil will contain about 54% of pore space. A sandy loam will contain about 51%. Now that is not too different. In one gram in a clay loam, there are 16,371 million grains of soil. In the sandy loam, there are only 6,485 million grains. There is a tremendous difference. By having so many small grains packed into a certain space, even though the pore space is greater, the pores have to be smaller. Therefore, the water can move through that soil only with the greatest difficulty.

Now can you visualize a cubic foot? In that cubic foot if you take all those soil grains and measure the surface of each one and add them together, you will get a certain area. If you spread that area out flat in a thin sheet, in our clay loam we would have 136 thousand square feet of surface in those soil grains in one cubic foot. In our sandy loam would be 66,600 square feet. Does that mean anything to you? Are you beginning to visualize what the inside of the soil looks like? I know it is going to be a little bit difficult to grasp, but don't let it worry you if you don't see it immediately.

If we could encourage the roots of grass to occupy the top 12 inches of soil, in a clay loam we would have a surface area of 15,610 acres for those roots to feed on in a 5,000 square foot putting green. In the sandy loam they can feed on only 7,644 acres. Now if the roots are only $\frac{1}{2}$ inch deep, then they can use only 637 acres of soil particle surface. Did you realize that the grass had over 15,000 acres of soil particles to work on under a 5,000 square foot putting green. There is something I really want you to think about.

The texture of the soil is relatively constant. You can't do much to the texture unless you modify it by the addition of sand, organic matter, and other materials. On fairways the kind of texture you have is the kind you will always have to work with, but the struc-

ture can be modified. I am going to use these little plugs of bent to illustrate what I mean by structure.

Columnar structure is an arrangement where the soil particles are sitting one on top of the other in orderly fashion. We find that in the wind-blown soils of the middle west and China. You notice that big pore space through here. That is what you get in those types of soils. But when those soil particles are rearranged by compaction or traffic, they fit very tightly together. The soil particles are squeezed to fit into the smallest space. This is what happens when you keep the soil continually wet and it is subjected to traffic and to the use of machines. This is a rearrangement of the soil particles that we have to correct. The only way we can do that today is through mechanical aeration.

Permeability is the ease with which water passes through the soil. We are learning how to measure permeability. We are developing simple instruments by which we can measure the porosity and permeability of the soil and it won't be too long before we will be doing that on the turf areas. You may be using it yourself. We have been giving it a lot of thought and I want to tell you now that we have just initiated a 5-year project at Stillwater, Oklahoma, to study the soils under specialized turf. It is a 5-year project that will cost over $5,000 and it is going to be the best of its kind that we have.

The three kinds of water that we have in the soil, I think you are all familiar with. But just for the sake of emphasis, I want to repeat it. One is the hygroscopic water. That is, the water that adheres to the soil particles by virtue of surface tension and the humidity in the air. If you air dry a soil, get it as dry as you can, and it will still contain 3% to 7% of water. It is hygroscopic. The plants can not use it.

The second one is the capillary water which is that which is held on the soil particles with a thin film by gravity. Gravity can not pull it away from those soil particles. I have heard some of you say that "a soil is overdrained". You can't overdrain a soil by putting in tile or a gravel base. You just can't because that soil will always contain a certain amount of capillary water depending upon the texture and the arrangement of the soil particles. The capillary water is the only water that the plants use.

The third is the gravitational water and it is the injurious water. It takes the place of the air in the pore spaces, drowns the roots, and gives us a shallow root system. What we want to do is to get that gravitational water out of the soil and as we take it out of the soil downwards, it pulls in air. If you take a fine glass tube and fill it with water, the water will slowly move down that tube pulling air in behind it so that when that tube is empty, it will be filled with air. The most desirable condition we can have is to have those pore spaces filled with warm, moist air. It not only gives us a warmer soil but also improves the conditions for the growth of micro-organisms. As you know, we have definitely destroyed practically all of the insects that tend to give us those non-capillary pore spaces in the soil. Therefore, we have to create them mechanically.

That brings us to the whole subject of drainage and I am not going to spend very much time on that because we have discussed it before. If you are not convinced of the necessity of drainage, you had better restudy the problem because there is nothing to take the place of adequate drainage. Sub-drainage to take the water out of the soil surface to prevent puddling and its bad effects. In a sandy loam soil which weighs approximately 82 pounds per cubic foot, it has a gravitational water capacity of about 15%. That is equivalent to about 12½ pounds of water to each cubic foot. That is equivalent to removing a sheet of water from the surface ten inches deep. So you see it is pretty important to get that gravitational water out of the soil. When it is in the soil occupying the pore space the soil is smothered by the choking of the root systems. The roots can not grow without air.

We are looking for deeper roots. Drainage will do that. Not only that but it will remove toxic substances that may be in the soil. That is especially true in the arid regions of the country. You would say that they don't need drainage out there because they don't have enough water now to grow grass. Yet they need the drainage because they often have an excess of toxic substances in the soil that can be removed only by downward drainage. If they do not remove those salts that way, those salts come to the surface by evaporation and accumulate and kill the grass.

The warmer soil definitely gives us playing conditions quicker and, on the public course where the gate receipts determine whether or not the course remains in

existence, that is an important consideration. The better physical condition of the soil through drainage and by having the system filled with air is incontrovertible.

Now there are dozens of tile drainage systems and I am not a drainage expert, but in preparing for this conference, I spent several nights reading a book on drainage and water and it was really worthwhile. It refreshed my mind on a lot of points. I didn't realize that there are that many systems of tile drainage as there are pictured in this book. The book is "Land Drainage and Reclamation" by Q. C. Aires of Iowa and Daniel Skotes of Texas A & M. There is a new one which we do not as yet have in our library because the notice only came yesterday. It is "Plant and Soil Water Relationships" by Paul J. Kramer of Duke University. It is my feeling that it would be money spent well by anyone spending his life growing grass.

We have been picking up some rather interesting comments lately especially from England on the use of the mole drain. We think it is going to have a real place in our plan of growing better turf. It is going to be a struggle; it is going to be a slow process; we are going to have to feel our way and know what we are doing. But they are using the mole drain in many of the heavy clay soils in England. The drains stay open anywhere from 5 to 10 years and give better drainage without the necessity of tearing up the turf and putting in new tile. The big thing that we are going to have to be concerned with in this area, as I said in the beginning, is to get more of the rainfall into the soil when it falls so that it will be there and available for plant growth. Replenishing our ground water supplies in the soil, and in so doing, we will be cultivating our soils, making them warmer, more desirable for micro-organisms. We will be developing deeper root systems so that instead of drawing on a few acres of soil surface, they will be drawing on many thousands of acres of soil surface.

I don't think there is any question in the three years now that we have been actively aerating large areas of soil but that this phase of turf improvement is here to stay. It is definitely improving our soil and the water relationships. I don't like to call attention to any particular club, but I am going to in this case. Pine Valley Golf Club has been aerifying their fairways probably longer than any one other club because they got the first machine. I was never so struck by the change in the appearance of the turf as

I was by Pine Valley when I saw the greens and fairways last fall. The turf was healthier than I had ever seen it before in my experience. Localized dry spots failed to develop on those fairways. They used less water than they had ever used before and they had less trouble. It is one of the most striking things I have seen. Scientifically, I can't prove a thing because we have made no measurements, but the improved turf is there to speak for itself. Many similar instances could be cited the country over.

-o-

SOIL FACTORS AFFECTING THE ABSORPTION AND UTILIZATION OF SOIL NUTRIENTS BY GRASS

Marvin Ferguson
USGA Green Section

It is always a pleasure to speak on the same program with people like Dr. Grau and Dr. Noer, but sometimes it pays to be on the program ahead of them. If you are not careful, they will say everything you were planning to say. There may be a little overlapping on what they have said and what I am going to say. I think all of us are emphasizing good physical soil conditions. We are going about presenting our cases in a little different manner or from several different view points.

I think the problem of nutrient absorption by plants is a very important one. It is also a very complex subject and awfully hard to study and understand. Last September Dr. Thomas, Dr. Noer and I attended a symposium at Madison, Wisconsin, on Mineral Nutrition of Plants. Maybe Dr. Thomas and Dr. Noer were able to digest what they heard out there, but when I left I thought that I was a little bit more confused than when I went there. For three days we heard people discuss different phases of mineral nutrition of plants and while they discussed many different phases of the subject and many of the different factors concerned, it was awfully hard to tie it all in one concise idea. You might say that it is hard to make one cover fit the whole thing.

The growth and development of any plant, as the physiologist looks at it, is a continuous series of chemical and physical reactions. Yet so many of these

chemical and physical reactions are going on simultaneously and inseparably that it is very hard to pick up any one phase of the subject and study it by itself.

I might say, too, that if I had not skipped the class at Maryland University this morning, I might be a little better prepared for this talk. I'm at the present time taking a course in Bio-physics down there and this morning the professor was going to lecture on Mineral Absorption by Plants. I skipped it and came over here to try to talk about it. I did swipe a copy of the outline for the lecture and brought it along.

I would just like to go back a little bit and review some of the elements we are concerned with in the nutrition of plants. From the air the plants get oxygen and carbon dioxide. Oxygen and carbon are two of the essential elements. From water we get hydrogen and oxygen and the mineral elements come from the soil. I think we can divide those into two categories. Many of you know that the ions of the various minerals that are taken up by the plant carry a charge. Some of those ions carry positive charges, some of them carry negative charges. So I'm going to divide them into two columns. The one on the left will carry positive charges and the one on the right will carry negative charges.

Those elements carrying positive ions are known as cations and are calcium, magnesium, potassium, iron, copper, manganese and zinc. Those that carry the negative charges are known as anions and are nitrogen, phosphorus, sulfur, molybdenum and boron. I believe those are all that are considered essential for plant growth.

Now I would like for us to try to visualize how these elements are held in the soil. The anions are mostly present in the soil solution. Those that are available to the plant are in the soil solution. The cations, on the other hand, are partly present in the soil colution and partly held on the soil colloids. Dr. Grau told us a little while ago about the surfaces that exist in soils of various kinds. You noticed that the clay soils had a very high surface area. Those particles themselves are much smaller, but the total surface area is much larger. Those particles in the soil that are colloid particles themselves are negatively charged. Therefore, these cations are the positively charged elements and are held by electrical force on the soil colloid. Those elements can migrate on the colloid from place to place and there is some

evidence now that the plants can take them up directly from the soil particles without their having to go into solution.

This matter of adsorption of the elements on the soil colloid is the basis for base exchange in soils. I know all of you have heard people speak of base exchange and the exchange capacity of different soils. That is why clay soils and soils high in humus have a higher base exchange capacity than those that don't have so much surface. You know that in sandy loam soils when you apply fertilizers, the fertilizer is held and stays there a long time because it is actually adsorbed on the surfaces by an electrical charge. It does not go into solution immediately to be washed away. Well, that is just a little bit of a background to try to give you a picture of the way in which the nutrients actually exist in the soil.

Now the thing we want to get to is the matter of how the roots of the grass go about taking up these nutrients in the soil. I would like to ask you to visualize two solutions-- one very high in salt concentration and the other very low. If those two solutions are placed side by side and separated only by a membrane, which was permeable to the salts contained in those solutions, you would expect that the salt would move to the solution that was of a low concentration. That is exactly what would happen through passive diffusion. The salts would move from the solution of high concentration to the solution of low concentration until the solution was equally charged with the salts throughout. Now when plant roots take up minerals from the soil, they are taking nutrients into a solution that is much more concentrated than the solution on the outside. In other words, the concentration of the plant sap is more concentrated than the soil solution, with respect to these mineral elements. So the plant actually has to push these nutrients uphill, so to speak. It is like trying to fill up a tire with air that is already partially filled. You must do some work to get the air in there. That energy must come from someplace.

Respiration in plants is the source of this energy which takes the nutrients in. Now in order for respiration to occur, three things are necessary. You must have carbohydrates which serve as a substrate. That is the material that is burned up in respiration. You must have oxygen for this process to be carried on and you must have a proper temperature. When we have plants growing, they have carbohydrates in them suffi-

cient for respiration. There is no problem there. Ordinarily during the growing season we have the correct temperatures. Maybe not always the correct ones, but at least temperatures at which this process will go on.

Then the limiting factor is oxygen. Oxygen must be in contact with those plant roots in order to allow the process of respiration to go on so that the energy can be developed for taking these nutrients into the plant. (Taking the nutrients uphill.) You can see readily that in a soil that is saturated with water you can't get enough oxygen in there for this process to be carried on.

There is another type of respiration that can be carried on in the absence of oxygen. This is called anaerobic respiration. It produces very little energy and it has been found that plants living only by anaerobic respiration lose some of the nutrients that are in the plant sap back into the soil solution. It is just what you would expect to happen if there were no energy being expended.

Then there is the matter of gas exchange. In the absence of oxygen there is quite an accumulation of carbon dioxide around the roots. Carbon dioxide is one of the products of the process of respiration. When there is a great accumulation of carbon dioxide around the roots, the roots lose their permeability. The membranes surrounding the cells in the roots will no longer allow water to pass. So the plant can not take up water when that occurs. When you get that sort of thing happening on the green, you call it scald. If you said to someone that your grass was wilting because it couldn't get water and your greens were saturated, you would be laughed at. Yet that is exactly what is happening. Your plants are wilting.

I know some of you in here may have had experience with cut flowers. You know when you break off a stem of cut flowers and those cells die near the tip of the stem, your flowers won't keep very long because even though you put that cut flower in water, it can't take up much of the water. But if you put those cut flowers under water and then break the stem, you have live cells in contact with the water and they will continue to take up water even though they have been cut off from the plant and this increases their keeping quality. That is just about what happens with grass, too. When you get carbon dioxide present in sufficient

quantities to have destroyed the permeability of the roots, you won't get water or nutrients taken in. The answer, of course, is good drainage and that is what Dr. Grau and Dr. Noer were talking about this morning.

The second part of the title of my talk was to be the utilization of minerals by plants. I'm afraid we do not know too much about the utilization of these minerals once they are inside the plant. It has been proven by experimentation that every one of these elements that we have listed is necessary. The plant can not complete its life cycle without them. Some of the things like nitrogen and sulfur enter into the protein content of the grass. They are a part of the protein molecule. There are other elements and they go into making up the plant cell walls.

There are others that enter into some of the chemical reactions that go on inside the plant. The enzymes in the plant can not operate properly without the presence of some of these elements. That is where a lot of the trace elements come in, such things as molybdenum and zinc and copper that are required in such small amounts that you can't see how they can possibly do the plant any good. Yet those materials catalyze some of the enzyme reactions that go on in the plant. Without them the plant can't carry on some of the processes that are essential to growth.

We hear a lot about nutrient balance in plants. And again we talk rather glibly about it, but we don't really know much about it. I think the theory is good. That is, if we have the proper amount of each element taken into the plant, then all the elements will be used for the maximum potential. In other words if you have a lot of potassium in the plant but have very little nitrogen, the plant can not make use of that excess potassium because it is being limited in its growth by nitrogen. So I think the concept of nutrient balance is a very good one, but it is also a hard one to study.

We are working on some experimental work at Beltsville now to try to determine the critical amounts of each of the elements that need to be present in grass tissues to allow that grass to attain its maximum growth and make the best turf. I think that when we are finished we will have a somewhat better basis on which to establish fertilizer recommendations. Now the success of this work, of course, will depend in part upon tissue analysis. The grass is being grown in the greenhouse with sand culture and is watered with a nutrient

solution. We know exactly what it is getting. It gets no plant food except what we supply. But we can not compare those conditions to soil conditions. The only thing we can do is to analyze the tissues of that grass and find out how much of each element has to be taken in and how far we can go towards increasing the plant growth by increasing the content of those elements. When we get beyond a certain point where a particular element isn't doing any good, then obviously we are not being benefited any by putting that element on.

Maybe I can draw you a graph here to show you how that looks. On this side of the graph is the content of any particular element, suppose we take potassium. With a very little potassium, we would expect a very little growth. As we increase the potassium, we should increase the growth. After we get out to a larger concentration of potassium, maybe we have on all the potassium that plant can use so we will get a leveling off of growth. Obviously we are going to get some yields down in here where the potassium content is very high and where the yield is very low. Now what does that mean? Well, it means that we don't have a need for any potassium but that there are some more limiting factors. Perhaps something like calcium or phosphorus is lacking in the plant and it can't use any more potassium.

I think we are going to come more to the use of tissue tests in evaluating the nutrition of grasses. I know that I am probably going to pick a fight with Dr. Noer and Dr. Thomas about that and I don't mean to imply that soil tests are not valuable. Soil tests and tissue tests, I think, can go very well together. Soil tests have one big shortcoming-- the fact that they do not tell you if the plant is able to get the nutrients that are available. Nutrients may be available to the extracting solution that the soil scientist uses. Yet if the plant can not get those elements for some reason or other, then they can't be used by the plant. We have a pretty hard time trying to manufacture some extracting solution that will do the same thing that the plant will do. By tissue tests we can find out whether or not the plant is taking those elements in and then, by using the tissue tests in conjunction with the soil analysis, we will know whether that element is in the soil but is not available to the plant or whether there is a lack of that element in the soil. Tissue tests merely tell us that it is not getting into the plant. It doesn't tell us whether it is in the soil or not.

I think that a program of this kind has been applied in California in the citrus industry. There they found fairly good supplies of nutrient elements in the soil but because of the alkaline conditions, they were not able to get the elements into the plant. It is also true in certain areas of Texas where there is a shortage of certain mineral elements in the plants that are actually present in the soil.

I think there is one other thing I ought to mention and that is the absorption of mineral elements through the leaves of grass. We have known for quite some time that if you put a little spray of iron sulfate on a chlorotic green, it would pick it right up. Apparently the iron in such cases is absorbed through the leaves. It doesn't have to go through the roots of the plant. We don't know much about that mechanism of absorbing nutrients through the leaves, but apparently it can be done. Recently there has been some work with nitrogen and potassium absorption through the leaves. I think that such applications may have some specialized uses. At the present time we don't know enough about it to recommend or tell you not to try those things.

Well, we have been talking around in circles and I do not know whether we have told you very much you didn't know before. I think we could summarize the whole thing and arrive at the conclusion that most greenkeepers do a pretty good job of fertilizing. We have not had too much trouble with the grass getting the chemical elements. If you use a good balanced fertilizer, you supply almost everything the grass needs. What we must worry about is whether the grass is able to take it up. The one thing that you can do about helping your grass take those minerals up is to supply oxygen. The way to supply oxygen is to see that you have good drainage and good aerification in your soil.

-o-

MANAGEMENT AND ENVIRONMENT AS THEY EFFECT THE CONTROL OF DISEASE ON BENTGRASS GREENS

William H. Glover
Fairfax (Virginia) Country Club

If I were a scientist I could give you concrete facts and answers that nobody could question. However, I am a greenkeeper and a greenkeeper can only look at what

he has to work with and try to figure out what to do with it.

Location has a very definite influence on how a green should be treated. Location influences the moisture content of the soil, the moisture content of the air immediately above the green and air circulation as affected by the surrounding trees and hills.

In regard to soil moisture, it is essential to know what the moisture content is. The greenkeeper should inspect the greens every day, or appoint a dependable man to do the job. Determining the moisture content is very simple. Either a homemade or a manufactured soil sampler can be used. If you take a plug immediately at the surface and you are able to squeeze enough moisture out of it so you can see it on your fingers, you have too much water in my estimation. The farther down you go the truer that is.

Someone asked me what is the relation between the soil and disease incidence and control. I don't know about that, but what we do to the soil is something else. There is a method of growing plants called hydroponics-- that is growing plants in water solution. You flood the plants, draw off the solution, let air circulate around the roots and the plants grow. You can produce almost anything you want under those conditions. But you can't do it with soil. If you flood the soil, unless you have optimum drainage conditions, you cannot draw off the solution by any means. That is where you get into a terrific amount of trouble. During very hot periods, comparable to what we went through this past summer, we lose sight of the fact that when there is a very high humidity, transpiration loss from the green is much less than during periods of high temperature and low humidity. We fail to take this into consideration in our watering program. We think it is terrifically hot, we have to put on a lot of water to keep the greens from burning.

I had a very unusual experience this year. I don't have definite facts and figures because I am not a scientist. But during this very hot season we made a definite attempt to see how little water we could get along with. The greens had been aerated with the Aerifier in the latter part of June, and previously, in the early part of April. They took water very rapidly, and not only took it but would dispose of it. The humus content of the greens is very near the maximum that Fred Grau mentioned this morning-- approximately 30% by volume. We felt that if we watered once or

twice a week to maintain enough ground water to support plant life, that was adequate. During extremely hot weather a little application of water during the day, if some drying out on the surface is noticed, is very desirable because it reduces the temperature some what at the surface and also reduces surface transpiration.

I don't know whether moisture content of the soil at night has much to do with whether or not we have disease, but I rather think that it does. I am sure that if a green goes into the evening period relatively dry underneath and on top, there is much less chance of developing fungus disease.

What does that mean? It means that during a difficult season such as we have had this year, a greenkeeper who has come along for years without too much trouble has suddenly gotten into trouble. It isn't because he has lost any of his ability to maintain turf; it means there is an underlying condition in the greens which he could get by with in easier years, but in a season like this year, with water-logged conditions under the greens, tremendous heat and humidity, no one could control anything because the trouble is underground.

If each of us were to start over again with the knowledge we have now, we would do things very differently. I am sure I would see that my greens were constructed as near to perfection as they could be.

I feel very definitely that disease on a putting green is tied up with the health of the turf. If we know each green, know its weak points, then we can take steps to cope with the problems. But some greenkeepers know their problems, but can't change the underlying factors which are causing them, and they are out of luck. They can only try to get the green committee and the golfers to recognize that during a bad season, disease cannot be controlled because some fundamental conditions are wrong. Perhaps this is a little away from the subject, but I think we must get the golfers to recognize that we are not little God Almighties, that we only have certain and specific things to work with. Unless and until we are able to create the conditions which will permit us to go through any season, controlling disease and producing the turf they want, we can only do our best with what we have.

-o-

UNION LABOR CONDITIONS

Walter W. Cosby
White Sulphur Springs (W. Va.) Country Club

I am not going to try to take up the general union conditions, but merely as it applies to us, or has applied for the last three years, to give you some idea of what working union labor does when you are on a golf course.

I went down there and found that I had union labor. Our unionization program started when the Hotel was taken back over by the New Management. They started an extensive program there to renovate the hotel and brought in contractors. Their labor scale was a good deal higher than our local scale was and, of course, it caused dissatisfaction. The men got together and went up to consult the powers, who refused to discuss the situation. They told them that if they didn't like it, they could go home. Well, to the surprise of everybody, they went home. So that was the beginning of the union labor. They didn't come back until they got a union. That happened in April and grass was growing so fast that it looked as though a scythe would have to be used. So they got their union that way.

Under our union set-up we divide our labor into three categories. Of course, the lowest category is plain labor which we use to dig ditches or whatever it might be. The second category is greensmen. They are paid 5¢ an hour more than you pay your labor. We only have one or two laborers on our course and greensmen are paid 5¢ an hour more than they are. The last category is the power operators who come 21¢ higher than the greensmen. That raised the labor scale by 30%, when they organized the union, so you can see what that has done to the cost of our course operation.

Now under union labor we find that we get a lot of lost motion. I am not condemning union labor; I am just telling you what happens with it. It is set-up so that if you have a greensman or two off either sick, drunk, or just stayed home, you can't put a laborer on that green. If you do, you must pay him the extra wages, if he works as much as a half day. You can take a tractor man or a power operator and bring him back on the green, but you must pay him the rate he would normally receive, not the greensmans rate. That is another thing that runs the cost up. If you

are out working and need a truck and you want to send a man down to the tool house to get it and haul something, you can't do that. You must send a laborer to get the truck driver who is working on the tractor to leave the tractor to go down to the tool house to get the truck, come up, haul the piece of lumber, take the truck back to the tool house, and get back on the tractor. This is a very unusual complication, but I know from bitter experience that is what it is.

As I told you, it raised our operating labor cost about 30%. That is, driving the company into more motorized equipment and that cost them still more to operate. The scale is higher but the number of men is fewer. In the long run I think we are going to have probably three less men on each course than we are operating with at the present time. Of course, it is going to be an entirely power operation.

The personnel that you get under union labor is probably a little bit above the average grade because you do offer them a higher wage and you get a better class of help. The absenteeism isn't quite as bad because, fortunately, the agent and the other union officials are very much opposed to absenteeism. They will back you up to the hilt on a question like that. That is one thing that you can do-- fire a man without any comeback from anybody concerned. If absenteeism becomes a regular thing, he is just gone.

It does require a little greater supervision because the authority has to come from the foreman. The men cannot take any authority on themselves which in some cases is very fortunate, but the foreman himself cannot operate any equipment, he cannot do any labor except in a strict emergency. If the water line shou d happen to break, of course, the foreman is there to turn the water off, but that is the end of it. He must go to see the plumber to get the thing fixed. He can't drive a truck or anything else like that, and, of course, you know all your foremen sometimes do those things.

Now that has run the cost up on us so we placed it on the golfer. The golfer is your bread and butter and he stands the cost and he is going to pay it regardless of what happens because you can't operate at a loss. You are going to drive some of the golf play away, but that can't be helped.

We have one unfortunate situation that we don't like. We can't work a man over 30 days without putting him

in a category. If you need a greensman, you must hire a man, work him 30 days, and then you must pay him the greensmans wages or else fire him. If any of you gentlemen can train a greensman in 30 days, you are all right. I can't do it. We have green help to start with. After the first year's work the turf looks all right, but it does hurt that first year with a new man, paying him the full greensman's wages and he can't do the work.

I referred awhile ago to the fact that the foreman can't do anything. I shall have to modify that a little bit and say that he can work if he has less than 5 men. If he has over 5 men, he can't do anything.

We had an instance come up not too long ago. We have many of the same thing, but I remember this one because two gentlemen who are in the audience happened to be on my course at that time. There was a broken window pane in the tool house. We couldn't fix it. Instead of measuring the window, cutting a piece of glass and putting it in there, I had to go to the engineers office, put in an order for somebody to come down to measure the hole, to go back, cut the glass, come down and put it in. That is an expensive proposition. Maybe you think that doesn't run into money when something like that happens. If we have a broken water line, we cut the water off, notify the plumber, the union plumber has to come down and look the place over. We furnish the labor to dig it out, he does what he chooses to do with it, and we refill it. We can't do any of that, only the labor part. We can't work a man from the golf course on the grounds. We can't work a man from the grounds on the roads or trails. You must work within your range.

That might sound like I am condemning union labor, which is not true. I think that most of the time it is caused by the management originally. Management has refused to cooperate with these fellows and they are pretty well fed up on it. They see everybody else making more money than they are and they are going to go to town on it. I don't think it is going to be very long until you are going to see more and more of it. There is a hotel and golf course very similar to our set-up forty miles away. They did try to unionize that last fall and it fell through. They lost out but the union renewed the charter for another twelve months. They are going to hit it this time in the late spring. You can't organize a golf course in September or October but you can in May.

The greenkeepers themselves have for a long time been advocating better wages, better working conditions, better education and better everything for the greenkeeper. I think it is about time that they enlarge their sphere a little bit and try to help out the men who are working under them. I have had very little trouble with the union for the simple reason that I have tried to go along with them. They are not after anything excessive. All they want is a fair break and that is what you are going to have to give them. Under the union they have a greater security. You can't fire a man because you don't like him or because you have had a little drink the night before and you don't like his looks. You must have a legitimate reason. There must either be drunkeness on the job, excessive absenteeism, or refusal to obey orders. Unsatisfactory work comes under that, too. With our union we have fellows who have gotten a raise in salary, they have job security, they have finally gotten hospitalization for themselves and their families, which is paid half by them and half by the company. They have gotten three paid holidays a year; they have gotten time and half for overtime. If you call the man after he has gone home, you must pay him for four hours even if he is only there 30 minutes. So that is another thing that runs up the cost. Now the fact that these men have security, have hospitalization, have a chance to make overtime is all to be credited to the union because the average company doesn't do that. They don't care anything about them. That is what is drawing these men into union labor. If you don't want to work with union labor, you had better get your club to be thinking about these things. You can't blame the men for it because they are looking out for themselves. Nobody has been looking after them.

I think that is about all I have on that subject. I haven't tried to cover it fully. I have a copy of the union contract here and if anybody would like to ask about it, I will be glad to tell you all about it. It is a problem that we are all faced with. Unless you do something about looking out for your men, then, within five years, you fellows who don't have union labor now are going to have to face it.

-o-

MY EXPERIENCES IN 1949

Robert Scott
Baltimore Country Club

All I can say from my experience here in the past with this excessively bad weather that we have had is, that the main thing to remember is "An ounce of prevention is worth a pound of cure." I am Scotch and I feel that it is only worthy of my nationality that I should accept that point of view and take advantage of it. We all know that there is a tremendous loss of water, as has been pointed out, and we should use the Aerifier and the Turferator so that you get the water into your greens during a watering period or when it rains.

The main things that I see are preparation and prevention. We are in a section where we know we are going to have trouble some time or another. I think it is foolish to know that we are heading for trouble and not be prepared for it. You may get away with it one year or even two, but it is going to come to you sooner or later. Then, your headaches are going to be more severe than they would be if you had spent some money instead of trying to economize.

It is said that you live to learn and then you die and forget it all. It is too bad if we can't pass on some of that information that we have learned through the years of experience. The points that have been brought out this morning about the soil condition and so forth remind me that the old-timers knew there was something wrong with the soil conditions which had to be improved before you could get the best results. In the old greenhouses they used to screen all the material used for planting. They screened all the coarse material out and made it as good looking and as fine as it possibly could be before they put it in their beds or pots. Accidentally one time they found that they didn't have time to put this material through the screen, so they pushed it into the bed and, lo and behold, the material in that bed was better than when they screened it for the simple reason that the coarse materials kept the soil from compacting, with the result that air and water reached the roots in more desirable quantity.

That applies to the conditions that we are up against in turf today. The better the aeration and the better the rooting medium you have, the better your turf is going to be. The tops are only as good as your root-

ing medium. The ground underneath should be as near perfect as possible for your tops to be as good as they can be. This can be done thorugh the use of the different equipment that we have now which will permit the water to get into the dry spots around the edges of greens, around banks of high fairways, and high places where the water has a tendency to run off. They will permit you to get air into some of the low spots on your fairways and into your wet spots in the greens. Turf will pass through the season a lot better than it would if soil had been left compacted.

This prevention goes a long way. You could map out a program whereby you can prepare for what you know is going to come. Sooner or later you are going to get dry spots at banks so they should be perforated so that water will go in there. If you have a wet spell and your green has been perforated, the excess water will run down into the holes, and more of the water will be stored underground than would be if soil was solidly compacted by tramping, rolling and cutting. I think that is one of the main things we must look out for.

We now have means of doing this work. We have the scientists working for us in summing up all these different materials for prevention of disease, prevention of compaction through machinery. But if the information is not applied in some general well-set plan beforehand, their work is not going to have the advantage that it would have if we outline the program in the spring and prepare for brownpatch, have so much material on hand, prepare for insects and have enough insecticides. This is very important in the prevention of these things.

The scientists are able to tell us what we should use for certain diseases, certain types of soil and, therefore, it is up to us to use it. We know our conditions, or should know them, in these different areas. We should have some means to prepare for all that is ahead. I think that is one of the things in which the greenkeepers are a little slow to realize. They economize a little bit too close to the bone. It is better to spend the money to get that prevention in time, than it is to wait until your trouble comes and then try to cure it. If you don't do that-- then you have two problems. There is the problem of getting the turf back, and the problem of the golfer giving you all these headaches about the condition of the turf. So I think the best thing that I can tell you from my experience through the years is to try to lay

some advance program and get that to the committee heads so you can get your material ready and have your equipment on the ground and working to be ready to attack the enemy as soon as it comes.

It is the same with weed control. If you didn't have some weed control program on your fairways, there is no use putting on fertilizer and watering because you are just feeding the weeds. Get rid of your enemy first and then treat your friends well and I think you will get somewhere. Get firmer friends, something like bent or U-3 bermuda and feed that. What's the use of going out and feeding clover and crabgrass and all those weeds? There are enough preventives on the market now to get rid of them. I think that if we get rid of the things we do not want and spend time and money for feeding the good turf, then we will get somewhere.

-o-

MY EXPERIENCES IN 1949

O. B. Fitts
Columbia Country Club, Maryland

We have had the privilege today of hearing some very enlightening discussions by O. J. Noer and Fred Grau, emphasizing the importance of proper drainage for putting greens, and I would like to offer my verification to, and support of their contentions.

It has been my experience and is my conviction, that without adequate drainage, it is impossible to maintain putting greens satisfactorily, particularly under the abusive conditions such as trampling, scuffing, mowing and rolling, to which most of our greens are subjected in all kinds of weather. Adequate drainage means both surface drainage and subterranean drainage. A minimum of two and one half percent grade is required to provide proper surface drainage. Sub-drainage may be provided by the proper use of tile or gravel layers. The area between the surface and the sub-drainage system must be provided by the use of soil materials that are porous enough to permit the water to filter through to the tile. This movement of the water carries plant nutrients to the grass roots and as it passes on, leaves the pores open for the circulation of air around the roots. The circulation of

both water and air in the root area is essential to the life and health of grass, and this can be provided for only by proper drainage and the use of the right consistency of structural materials.

As for 1949, my experience was somewhat out of the ordinary inasmuch as we were confronted with the detestable problem of re-habilitating our greens after a disastrous 1948, when they were ravaged by an uncontrollable scourge of small brown patches and an apparent toxic condition that rendered the grass irresponsive to the ordinary program of fertilization. We used every known remedy for brownpatch in 1948 without any noticeable results. In fact, I am convinced now that we used too many, and too much of some materials and that the excessive use of chemicals in our desperate efforts to control the brownpatch was responsible to a great extent for lack of results from our fertilizing program. As a result of all this our greens were a sorry lot at the beginning of 1949.

I was so disgusted with the results of our efforts in 1948 that I determined to try an entirely different program for 1949. I gave up all the brownpatch fungicides except Calo-clor which I mixed with Milorganite and applied dry, and then watered it in. This was repeated at weekly intervals and at the rate of two ounces per one thousand square feet, until the fungus was checked, and then cut to one ounce per one thousand square feet and after two months to one-half ounce per one thousand square feet. This did the job as far as brownpatch was concerned.

We had used Tersan, Semesan, F-537, Soilicide and Pura-turf the previous year trying to find something to check this disease, all with no good results.

In our fertilizer program we started the spring as usual with ammonium sulfate mixed with top dressing material, followed by an application of Agrico fertilizer a week hence. At the suggestion of Marvin Ferguson we began applying sulfate of ammonia in solution. This was applied with a sprayer and then watered down at weekly intervals and at the rate of about one pound per one thousand square feet. This brought the color back to the greens in a few weeks and kept them good all summer. This, with two supplemental applications of Agrico fertilizer at the rate of four pounds per one thousand square feet in July and September, plus the four pounds per thousand square feet weekly applications of Milorganite used with the Calo-clor, rounded out our fertilizing program for the season and the results were very satisfactory.

IMPROVING THE RELATIONS BETWEEN CLUB MEMBERS, GOLFERS, PROFESSIONALS AND SUPERINTENDENTS

David Halle
Baltimore, Maryland

There is no question but that club members, golfers, professionals and golf course superintendents are all in favor of more and better cooperation. In addition to cooperation, Bob Williams and I were discussing a short time ago the amazing lack of a group or body whose function would be the inter-change of information between clubs regarding problems of golf course management. In my opinion, the Middle Atlantic Greenkeepers Association, the Maryland State Golf Association and the Middle Atlantic Golf Association are equally to blame in not having taken a step in this direction.

I should like to see a real effort put forth by these groups in establishing a small discussion group and possibly putting into written form the information which would be so valuable to all of us. In our own case, we lost our greenkeeper a few years back and were very much handicapped by not being able to go to a source of reading material that would help us. Fortunately, we had a young man available to take over the job and were further blessed by a golf professional who had an unusual knowledge of course maintenance and was willing to give it the time. Were it not for those facts and the generous help of both Carroll Hitchcock and Bob Scott, we would have been up against it.

I feel that the days of jealously guarded secrets should be at an end and that the members of your association who have been in this game so long and gathered such valuable experience through the years might well consider problems of equipment, general planning of course maintenance and put it down in writing where it would be available for all to study.

The Maryland State Golf Association, of which I am an officer, would be delighted to appoint a committee to meet with a committee of yours and try to make some progress along these lines.

-o-

IMPROVING THE RELATIONS BETWEEN CLUB MEMBERS, GOLFERS, PROFESSIONALS AND SUPERINTENDENTS

Robert Williams
U. S. Naval Academy Golf Course

I find that I am in the same situation as some of these fellows who followed this morning's speakers and were second and third in line. The people ahead of me have more or less stolen my comments.

Improved relations between the golfer, the greens chairman, the professional and the superintendent, I think can be best accomplished by a definite educational program which covers quite a bit. When I say definite educational program, I mean: keep the chairman of the Greens Committee completely informed on what you are trying to accomplish, what your situation is, and what troubles confront you. He can best pass this information along to your members. I believe if you take the time to tell each member why you are doing this or that, you will spend a lot of time in conversation and accomplish nothing, or very little.

I was talking to Mr. Halle, Chairman, Greens Committee at the Suburban Country Club, Baltimore, Maryland, about a program of trying to set up some definite plan for the maintenance of a golf course. I think we could do a lot toward standardization of methods by getting together from time to time with 4 or 5 of the best maintenance men in the community. They could determine the average number of men needed for maintenance, the fertilization program and things like that.

I am in an unfortunate situation because sometimes I have a change of chairman as frequently as 2 or 3 times within a year. I get a new chairman and he wants to make a good name for himself. The first thing he usually wants done is to operate at a lower cost. I am continuously finding that situation. Possibly most of you men have that to contend with also.

I think if the Green Section or the golf course superintendents were to set up some standard that says, for instance, that it requires so many men to maintain an 18-hole golf course during a year to keep it in first class shape, that you should apply so much fertilizer to expect normal growth of grass, that it requires so much water, etc., then I think we would present something in black and white to each chairman and then

make the adjustments needed for particular situations. Too often, I think, the greenkeeper is doing a good job, but the people in charge, who are lacking in practical experience, feel that their methods might be better. I know one particular course where a lot of the members are engineers. In their particular profession they may be experts, but when it comes to the maintenance of a golf course, they do not have the practical experience that is required to keep a golf course in the condition that the average golfer wants.

I feel that we can best accomplish improved relations by keeping both the golfer and the chairman well informed of what they can expect, of what it will cost them, and of how the program should be accomplished. I think too often we get criticism from those who do not know what they are talking about. I think anyone of us is willing to accept constructive criticism. At my club, we had a suggestion box at the golf shop. Some of the suggestions that came into that box sounded like children's. But in general we got a lot of very good suggestions that were carried out and everyone concerned benefited by it.

In conclusion the main thing I would like to pass along is that I think we can get the best cooperation by educating the people we have to deal with, including the club professional, the chairman of the greens committee, and the golfer. The golfer himself can go a long way in simplifying the maintenance problems by repairing the ball marks on the greens, replacing divots, smoothing marks that may be made in the sand traps and things like that.

-o-

IMPROVING THE RELATIONS BETWEEN CLUB MEMBERS, GOLFERS, PROFESSIONALS AND SUPERINTENDENTS

Charles Schalestock
Farmington Country Club, Virginia

This subject has had excellent coverage by previous speakers. It would be difficult to elaborate on it. However, I would like to stress a point or two.

In my opinion, the key to a successful golf course management, maintenance and social relationship pro-

gram hinges on the degree of cooperation existing between everyone concerned. There cannot be success without realization of this cardinal point.

Where the club's business is administrated by a general manager, he must be a man of high caliber and versatility. If the scope of his duties is too great for him to direct all phases of operation personally, he should engage only qualified assistants. In this category of assistants, his key man on the golf course is the greenkeeping superintedent.

The greenkeeping superintendent is a turf specialist who has devoted his entire life to all phases of golf course maintenance, and is therefore qualified to assume all responsibility for this position.

The manager and greenkeeping superintendent should confer regularly on all matters of policy affecting any phase of maintenance. There should be no unilateral action by either, as this would seem to indicate that one or the other is not wholly competent, and therefore, unnecessarily employed. Furthermore, unilateral action is not conducive to a harmonious and effective relationship.

The above principle is equally true in the relationships between the chairman of the greens committee and the greenkeeping superintendent. In either case the greenkeeper is sufficiently qualified to supervise all actual maintenance without interference. However, the greenkeeper should at all times be pleasantly receptive to any and all suggestions from members, greens committee, manager and professional.

The members should realize that their greenkeeper is a conscientious artisan who takes great pride in his work. It is not uncommon for him to devote twenty-four hours a day to his work during critical periods which sometimes last for three months in the course of a year. This devotion to his duties should certainly merit complete cooperation from the members. They can best serve the club's interest by observing all the rules and etiquette of golf. Such conduct not only results in a better groomed course, but creates a more pleasant environment for all.

Many clubs practice false economy. This is an important point. In my opinion, hiring labor on a "seasonal" basis is an unwarranted extravagance. Much time is required to train a man for golf course work. Where the labor turnover is high, the club is con-

stantly manned by inadequately trained help. Such a condition is preventable. Certainly, some members could furnish temporary employment for the golf course workers between seasons. Such an arrangement would have to be made with tact, so that the club would not lose their trained workers.

Several points were brought up by previous speakers. They used the term, "plain labor". What constitutes "plain labor" on a golf course? Frankly, I would hesitate to use the term. A well trained worker covers many of the following phases of maintenance at most clubs. He drives a tractor, mows greens, treats turf with chemicals, fertilizes, limes etc., makes minor machinery repairs and adjustments, waters greens, does tree work and many,many other jobs. Let us take just one of these tasks, namely, watering greens. This sounds simple, but how many men really know how to do this properly? To sum it all up-- no job worth doing on the golf course can be done by "plain labor". For a well integrated maintenance program,each workman should be properly trained to do a variety of jobs.

Some organizations entail considerable expense in hiring a so-called "labor relations" or personnel manager. If the greenkeeping superintendent is sufficiently qualified to handle men,he should be in a better position to maintain proper labor-employer relations than any personnel manager because of his constant personal contact with the men. Here again, cooperation is the key-note. No one will do as well a job by a cold and impersonal director. Everyone tries to do it properly if an appeal is made to him in a psychological manner. Even a simple task, if done well, gives a man a keen sense of satisfaction. This is all a part of training so-called "plain labor".

-o-

WARM AND COOL-SEASON GRASSES

Fred V. Grau, Director
USGA Green Section

(Note: Actual plugs of turf were shown to the audience and discussed each in turn by Dr. Grau.)

The zoysia project being developed cooperatively by the U. S. Golf Association Green Section and the U. S. Department of Agriculture is the only full scale breeding and testing project of its kind in the world.

This grass has been with us in this country since 1900. We just now are coming to the point where we are going to put this grass to some use. It has greater possibilities, I think, than almost any other turf grass we are using today; possibilities because it is tremendously heat resistant. It grows its best during the heat of the summer. No disease has been known to attack it. The soil under our plots is filled with Japanese beetles, but we have yet to notice any injury on zoysia from Japanese beetles. It is a good seed producer and it can be planted either vegetatively or from seed.

The next step is to get zoysia into commercial seed production, which is not very far off. Its chief objection is the brown winter color. We are overcoming that by combining it with improved perennial cool-season grasses that hold their color during the cool seasons.

This seedling plant of zoysia set in a thumb pot looks very similar to a bermuda plant. The stolon crawls along, hugs the ground, crawls under crabgrass and clover, smothers them and chokes them out. Crabgrass has no chance with zoysia. Zoysia is a low fertility grass. It can exist at a lower fertility level than almost any of our other grasses. Some of the seed that the Green Section sent out 20 years ago has produced turf that has been highly successful during those 20 years without any irrigation and without any fertilization. That is rather remarkable. About the only grass that has stood up with zoysia is bluegrass. The bluegrass will have an increasing place in our turf program as we begin to use zoysia. Incidentally, one of the worst weeds in zoysia seed fields is bluegrass.

Ferguson is working on the nutrition of Z-52 for his PhD. thesis to find the level of fertility that will give us the best results both from the standpoint of vegetative growth and from the standpoint of seed production. A great many of you have the opportunity to plant some of these selected strains of zoysia on your golf courses, in your nurseries, and increase them vegetatively and also to harvest seed because this grass does set seed in this area. Some of the strains of zoysia have produced up to a thousand pounds of seed to the acre. At the moment there is not enough commercial supply of seed to set a price on it. According to Ferguson's data, the best time to plant seed is in the middle of July. We get a solid turf in one year from as little as ten pounds of seed to the

acre.

From this 4-inch plug of zoysia, the seeds will be harvested during the winter. When they mature, they will be scarified to take the hull off, and planted in flats to produce seedling plants. In the spring we will set these seedling plants out on 2 foot centers. They will produce virtually a solid turf in one year. This 4¼ inch plug, if handled in that manner, will produce from 10 to 12 thousand square feet of turf by this time next year. An ounce of that seed handled in this manner will plant 6 acres. It is rather an expensive way of doing it, but from our experience you do it once and the turf will be there for the rest of time. We have not as yet seen anything happen to zoysia to take it out of the picture.

The root systems of zoysia look and feel like wire especially when you try to cut a plug. It is very deep rooted, very drought tolerant and is certainly going to give us golf turf throughout the playing season when most of the golf is played. I don't see very many golfers out in our winter weather so that a little brown color during the winter probably isn't going to be as bad as we think it is right now.

Question: Is there any chance of losing large areas of Zoysia japonica in an exceptionally cold winter?

No, we think not. It has been tested at State College, Pennsylvania, and it has come through 32 below zero with the frost down about 3 feet. It came out green about the first of May.

Question: How is it for tees?

It is not as rapid healing as bermudagrass. We are thinking of zoysia more for lawns, fairways, roughs, parks and cemeteries.

Here is turf from seed of Z-52 zoysia with Merion bluegrass starting in it. The Merion bluegrass was seeded last spring. It had to struggle during the summer as seedling plants in competition with the zoysia and the heat and drought because none of this turf has ever been irrigated. It is all produced under natural rainfall. Still the Merion Bluegrass is coming through now after standing that competition all summer. I think it is one of the really excellent combinations.

Question: How did you plant the Merion bluegrass seed

is the solid turf of zoysia?

The bluegrass seed was planted by thorough aerifying, dragging, and seeding. The zoysia turf was opened sufficiently to let the bluegrass seed into the turf where the roots could strike into the soil.

Question: Do you think that poa annua would survive with the zoysia?

It definitely will. Poa annua is one of the better cool-season grasses in combination with either zoysia or bermuda. It is one of the naturals. At a meeting of the New York-Connecticut Turf Association not too long ago, I saw one golf course that had gone pretty solidly over to U-3 bermudagrass for the tees. This spring when the poa annua is out in seed and they mow it, they are going to go back, use a sweeper and pick up all that poa annua seed, cure and dry it and put it in the barn. In the fall when the bermudagrass starts to go dormant, they are going to take the poa annua clippings and scatter them all over the tees so that they will be sure to get poa annua back on their tees. Remember that this is in Westchester County in New York. That is rather a revelation.

Now let's see what some of these other cool-season grasses are doing with the zoysia. Here is straight Alta fescue that has been mowed between 3/4 and 1/2 inch all summer. It makes a lot of growth in the cool weather. It is coarser than most of our other grasses. Alta fescue in combination with zoysia is not too coarse. It has been kept under 1/2 to 3/4 inch mowing and the Alta is getting better every year. It is not crowding the zoysia, neither is the zoysia crowding out the Alta fescue. We would like to think of this combination as a little bit better suited to parks, cemeteries, golf course roughs, perhaps more than to fairways, and yet I would not turn this combination down as a fairway turf because it is so drought resistant, and so deep rooted. It has nearly all the qualities that we are looking for in a fairway turf.

One thing that we must keep looking for is economy. The tremendous increases in cost of labor make it necessary to find every possibility for cutting down on costs. Certainly we must keep working towards those combinations of grasses that will persist and thrive at the lowest possible level of fertility with a minimum of water.

Another good combination is zoysia and Penn State

chewings fescue. At first we thought that was a failure, but it is getting better year by year. It is two years old now. The chewings fescue is not as green as Merion bluegrass, but we are going to have to forget a little bit about this high color if we are going to have economy turf. With our breeding program, there are even better fescues coming out than the Penn State chewings and yet this is one of the best available today.

Question: Are those grasses fed heavily?

They have not been fed heavily. These plugs that I am showing you got two pounds of nitrogen to the thousand square feet last year. That is a very light application of fertilizer. Once they are established, they can exist with very little fertilizer.

Question: Would heavy feeding help the color?

It would definitely. If this had had one more pound of nitrogen in November, this would be much higher in color, if color is what you want. But for my money, that has all the color you need. In addition it has quality from the golf standpoint.

With our zoysia and cool-season grasses, we are getting a cushion of turf on the surface. We have been afraid of that cushion in the past because we had no way to overcome it. It will provide an insulation against the evaporation of moisture. It does one thing, it keeps the soil cool. In the hot weather of July and August, keeping the soil cool is of tremendous help. It will help to keep our cool-season grasses growing through that heat period. Now with the aeration equipment that is available, we don't fear the organic layer on the surface because we know we can puncture it and get water down through it. Yet it does provide resilience and a cushion on which to walk and on which you play a shot that is just out of this world.

With these grasses we have deep rooting in unfavorable soils such as we have never had before. That means permanence. In many of these plugs, we found Aerifier holes and it was amazing to see the root growth down in these holes. See these roots hanging down there? That is an Aerifier hole and it is completely filled with roots.

This is another strain of zoysia into which we seeded B-27 this past spring. In spite of the summer temper-

atures and the competition with the zoysia, the B-27 is still making a turf in the zoysia. So we have every confidence that by adjusting the rate and time of application of fertilizer, we can be completely successful with the combination of grasses.

Question: You mentioned adjusting the fertilizer program. Do you mean by that feeding in the summer for your zoysia?

Yes, let me give you an illustration. That is one of the things that we are more or less going to have to guess at on the basis of our past experience and knowledge. But I would say this, if you have a good turf and can keep it going through the summer, you will do better with your cool-season grasses if you will feed the cool-season grasses in the fall when they start to grow. Because where we had our bermudagrass heavily fed through the summer, we practically were devoid of cool-season grasses. The competition was too heavy. So we are going to have to adjust that according to the way the turf is acting.

Here is U-3 bermudagrass cut for two years at putting green height. It has been a very satisfactory putting green, cut at $\frac{1}{4}$ inch. It has had no irrigation whatever. We have been talking about the water shortage. They are telling me the thing they are going to need in the New York area as early as next summer is the information on how to produce putting greens without water. Well, I think we have at least a step on the road because we know that it will stand putting green height, it will grow up there and we know that with its deep rooting qualities, U-3 will require but very little additional irrigation beyond natural rainfall. By aeration and feeding to get every bit of rainfall into the soil, we are pretty sure we can produce greens in this area without artificial irrigation. It will not be as good a putting green as bent, but it will be an acceptable putting green.

Now we have the combination of bermudagrass with some of these other cool-season grasses. For instance here is U-3 bermudagrass with Alta fescue. They have been cut at $\frac{1}{2}$ inch fairway height and has been a perfect piece of turf. That Alta fescue is not coarse and ungainly as it is when it grows with very little mowing. That is not too bad a combination for a fairway or a tee. So don't throw Alta out of the window because it is coarse. It does have a place.

Question: Will the other grasses crowd out Alta fes-

cue?

It is not doing it. This is a piece of Alta fescue and bermudagrass which has been cut at ½ inch with no irrigation. The Alta fescue is gaining; even though it was a late fall seeding, there is a thin stand of Alta fescue and it is gaining on the bermuda. It is making quite a nice combination.

Here is an example where we fed the bermudagrass too heavily during the summer. The Merion is having an awful struggle coming back. This summer we will feed it only enough to keep it growing. We will feed it heavily in the fall when the bermuda goes dormant and the bluegrass starts to grow.

Here is a combination of U-3 bermudagrass and Arlington (C-1) bent. It was established in July by sprigging. We mixed the U-3 and the C-1 stolons together, put them down vegetatively and this is what we have now. We think by proper feeding we can maintain that balance fairly well. This combination should not require any irrigation.

At a course at Westchester County, New York, they built several tees of U-3 bermuda in the middle of June. In the middle of July they opened those tees to play and when I saw them in October, they were in perfect turf. With all that heavy play, they were not able to knock out the bermudagrass. In many cases by plugging U-3 bermuda into tees, you don't have to stop playing at all. In many cases the golfer will tee the ball right up on that little plug of bermuda because it is the best grass and he will knock the top right off, but it will still go right on growing. About an inch down are the heavy rhizomes of bermuda. You can strip sod one inch deep and within a month it will be heavy turf again. You can't destroy it by taking the sod off.

I know the minute we started talking about bermudagrass, every single one of you said that you didn't want any of that around because it would start to crawl into your greens. The better bents will pretty well keep bermuda from crawling into the green. Here is one of our newer bents, C-115. I could just as well have brought along a plug of C-1 bent because in Oklahoma where bermuda is giving the most trouble in the greens, the bermuda has come into the greens hardly at all where they have C-1 and C-19 or C-1 alone. But with common ordinary bents the bermuda will go into the greens at least three feet in two years. The

better bents will provide better competition. The average golfer will never know that he isn't putting on pure bent if you have a combination of bermuda and C-1 bent. What I am trying to say to you is not to be too afraid of bermuda up close to the greens because there are several controlling factors that we can employ. If it gets too bad, we know we can kill it completely and replant the area with something else.

Here is U-3 bermudagrass and Canada bluegrass. We have said very little about Canada bluegrass and yet in some of our areas there are very fine stands of it. This piece is ten years old and the Canada bluegrass is thriving and spreading in the bermudagrass and giving it a good winter color. So it is another possible combination. We have a lot more work to do on that.

Here I think the time has come, with our limited budget, our limited personnel, for you fellows to do a great deal more in the way of practical research now. We have gone just about as far as we can with what we have to work with. Now if you will plant test areas on the golf courses and in nurseries and try out these different combinations, you will learn more than by trying to learn it from us. In addition, it will give us a lot more to talk about at these conferences in other years. Next year I would like to see a discussion of some of these newer grasses that have come on the market. Quite a few of you have test plots of Merion bluegrass. How are they doing? Quite a few of you have plantings of Alta fescue. I think a report like that in another year would be very excellent.

Question: Do your bentgrass plots ever mix with the bermuda by mowing both with the same machine?

Yes, in fact what we are doing is planting bermuda between the two bent ranges so that the bermuda will spread into the bents if it is going to. This plug is bermuda and C-115 bent mixed, where the bent has grown further into the bermuda than the bermuda has grown into the bent.

-o-

CONTROL OF WEEDS IN TURF

R. H. Beatty
American Paint and Chemical Co.

I am going to tell you something about the new growth regulators for turf work so that you may have some idea of what they can do, and what they won't do. I will run over 2,4-D rather quickly because I think most of you men have worked with that compound and are well acquainted with its properties. 2,4-D acid itself is regarded as insoluble. The chemists make 3 forms which have appeared on the market-- the salt, amine, and the ester. The only reason they make these is to get the 2,4-D into solution. When we first started to work with it, I remember that we used carbowax. That has been dropped and the salts have been dropped in our 2,4-D work in crops, mainly because they are not as soluble as the amine and ester forms, and also because the esters of 2,4-D are more effective weed killers under unfavorable conditions.

The amines are excellent weed killers for turf work, since they are entirely non-volatile and are easier on grasses. The esters work better in the southwest and in the dry regions where soil conditions are more stable, and seem to penetrate certain weeds better. Last year's 2,4-D ester formulations all had the disadvantage of volatility. This year we are happy to say that we can offer you a low volatility ester.

There is one very important difference between amines and esters. An amine is not volatile. You probably have heard a lot about this "volatility of esters". Today we all agree that the esters of 2,4-D are volatile. Now, what does that mean? They give off a gas, or a sort of fume. You can spray them in half of this room and put a tomato plant in the other half of the room. That tomato plant will soon start to twist out of shape as it grows. The "gas" coming from this ester is enough to have this effect. This year we ran a field test on volatility just to see how far it might affect plants. We treated an acre with an amine and then we went a mile away and sprayed an acre with an ester. Just before spraying we had tomato plants planted on all four sides of this field. We planted tomatoes immediately after spraying and every day after that. Well, the results of the test showed that spray drift of the amine went 40 feet and injured tomato plants put out before spraying. We found no injury from the amines after the spraying was over,

planting our tomatoes every day. But with the ester, up to the sixth day we injured new tomato plants 195 feet from where we sprayed. Then we ran out of tomato plants. I don't know how long it would have continued.

I had an opportunity to do some work on woody plants in Georgia. We sprayed a right-of-way and injured cotton a mile away. Cotton is more sensitive to 2,4-D fumes than any other plant that we know of. I mention that to emphasize the fact that, if the amines will kill your weeds, it is best to use amines. If the amine formulation does not kill your weeds as well as ester, I would certainly suggest that you use the new low volatile ester type.

1 or 1½ pounds of actual acid per acre is ample to take care of most of the annual weeds you encounter. We have found through the years that annuals are killed more easily when they are young. The perennial weeds, which you don't encounter very much in your turf work, are killed more easily when they are in the bud to flower stage. There are some resistant broadleaf weeds on which 2,4-D is not doing as good a job as we would like and we are all working on materials to do the job.

You are going to hear a lot about 2,4,5-T. I remember that in our early work with 2,4-D, we thought that 2,4,5-T was the most active of the group. At that time we were testing on poison ivy. We have gone back to the 2,4,5-T in order to do a good job on woody plants. We started a very enterprising campaign to eradicate woody plants. We were doing pretty well with most plants, but when we came to brambles, we couldn't do anything. A year after spraying, the whole right-of-way would be covered with brambles. We soon found that 2,4,5-T took the brambles out. For your work, as low as ¼ pound of 2,4,5-T would do a very good job in the fall in eliminating clover. I would say 1½ pounds would be a fair amount to use in order to get the annuals and clover. 2,4,5-T is a little harder on grasses than 2,4-D. We have noticed that time and time again. Now many men are working on this compound to kill crabgrass.

Another one of the relatively new chemicals which has been publicized in the last year is TCA. I don't know that this compound has any great selective property. I only mention it as an eradicator of weedy grasses in traps and in driveways or wherever you men want to clean up grasses. Up to 100 pounds per acre is required. It is relatively non-poisonous and easy to

use. However, I do want to caution you to wash your sprayer out thoroughly with water because it tends to be rather caustic.

Most of you men are interested in the eradication of crabgrass. You have seen some new compounds come on the market in recent years, for instance PMAS. PMAS looked very good to us in our tests. However, it is poisonous and it does cost a few dollars. There has been a tremendous amount of research work going on during the last few years to find a compound that is non-poisonous and which would be less expensive. Dr. Sowa, a former teacher of chemistry at Notre Dame, has been very much interested in this problem and has worked with several compounds which were tested at Rutgers during the past two years and which look very promising. They are non-poisonous and relatively cheap. However, we do need another year or so for testing these compounds.

Potassium cyanate has been worked with for the past two years. We think it is excellent and introduced a potassium cyanate formulation this spring. Silver crab has been reported to have been killed with it, but I have not yet seen it. I think that you might try it on silver crab. We like it for the simple reason that it is non-poisonous. It is relatively inexpensive. It will take about 8 to 16 pounds to the acre and sells in the neighborhood of $1 a pound.

It has some unique properties and I think there are certain things that you should keep in mind when you use it. It is very soluble in water. We found that under dry conditions like we had last summer here in the east, it would not work at all. If you have dry weather during the time you want to kill the crabgrass the area to be treated should be watered thoroughly two or three times a week or so before applying it. It does burn up the tips of the bluegrass a little bit but on the first cut you remove the brown tip. We fouod that 8 pounds to the acre, put on with a large amount of water will do the job on seedlings. Mature plants require 16 pounds per acre. With low amounts of water, we did not get as good results as at the high rates. It is a contact killer. We don't think it has any root absorbing properties. It is completely broken down only two or three hours after it has been sprayed. It has no toxic effects afterwards in the soil or on the people who are using it. You could use 2,4-D with potassium cyanate. However, I would like to warn you to use low amounts of 2,4-D. I would not go over one pound to the acre because we did get some burning where we used more 2,4-D. One thing you

do need with potassium cyanate is a good wetting agent which we have incorporated in our formulation. The amount of wetting agent and the type of wetting agent are very, very important. We tested over 20 of them last year; Rutgers tested 15 or 20 and noticed big differences between them.

-o-

CONTROL OF DISEASES OF TURF

H. W. Thurston, Jr.
Pennsylvania State College

A good many of the remarks indicate that turf management is going a long way toward solving some of the disease problems. Those remarks are very welcome to me. I hope the time will come when some of these new grass combinations are the way in which you will be able to handle disease, thereby doing away with chemical treatment for disease. At that time my services will be devoted to some of the other crops where the problems are still numerous.

One new thing I do have to bring you today concerns national cooperative tests of fungicides on turf grasses. This test was set up through the American Phytopathological Society, the professional society of plant pathologists who have been for several years interested in cooperative tests of new materials. We finally persuaded them to set up a sub-committee and to set up such a test on turf grasses. Such a test was set up this past summer for the first time and 8 different locations were involved. One was in California, one in Iowa, one in Massachusetts, one in Indiana, two in Pennsylvania, one in Ottowa, Canada, one in New Jersey and one in Wisconsin. Wisconsin was one of two where they said they didn't have any disease this year so the figures from those states will be blank.

Ten different chemicals were used in this test and in each test the small plots were repeated four times. The treatments were put on at regular intervals starting with the first appearance of dollarspot. The number of treatments made during the season did vary somewhat in the different states. I notice that California put on four treatments beginning on August 10th; Iowa put on nine treatments beginning the 26th of June; Massachusetts, five treatments beginning the

19th of May; Pennsylvania, three treatments beginning the 19th of May; Indiana, four; Rhode Island, nine on one plot and two on another and so it goes. The taking of the records on control of dollarspot varied somewhat. Some areas counted the number of dollarspots on the plots, others counted the number of dollarspots per 100 square feet; still others attempted to rank the treatments from best to worst in six different categories. Now when you try to assemble that data, the best we could do was to determine the average rank of the areas. Those figures I will show you.

I think we are ready for the slides now. This represents two plots in Pennsylvania, one where we did not get any control of dollarspot and one where the control was pretty good. This represents the corner where four plots come together. This represents a couple of plots at Pennsylvania State College where Musser has different strains of grass. This area represents a strain resistant to dollarspot.

Now here are the figures from all the 8 areas where there was any dollarspot. The last column represents the ranking of those experiments. You will notice, ranking them from one to ten, that Tersan is at the bottom. Notice the three that came out best-- Cadminate, 531, and Pura-turf 177. Those are all about the same class. You may want to know why these blanks are here for Pennsylvania. This test was set up and summarized by Dr. Rowell. When he set this up he suggested a list of chemicals. In Pennsylvania we told him that we had had a few years work with some of the chemicals and we knew what they did. We told him exactly which were good and which ones were not good. But it does give me a little satisfaction to come here and show you that results from other areas in the country back up what I told you a few years ago about the dollarspot control.

When it comes to large brownpatch that is a different story. On these same plots that were laid out for dollarspot control a few were able to get data on large brownpatch control. We got some in Pennsylvania. This series of plots are on Joe Valentine's nursery. Here is one of our new materials that we were trying and that goes under the code number of 1025. It is an attempt to add something to 531 which will make it do a better job on large patch. It did fairly well. This is a slide loaned to me by O. J. Noer. This is large patch on a susceptible variety of astoria bent. So far as large patch is concerned, we do have some

resistance in the various strains of grass that have come through the past season without any trouble.

None of the materials were particularly good for large patch control. Of course, the plots here were not set up for large patch, but for dollarspot. These are also large brownpatch figures. This is the actual percentage of area covered by large patch at its worst. Here are a few figures from Pennsylvania in the four plots on dollarspot control. We had a check. We had three materials under the code nimbers 1025, 897, and 531. These are counts made at the height of brownpatch during the 21st of June and the 6th of July. 56% of the plots were covered with large spots on the 21st of June. Four days later the grass had begun to recover, but the scars were still present on July 6th. A treatment was made on the day those records were taken, and four days later the disease had dropped down to pretty nearly nothing. If this indicates anything at all, it does indicate that, where you are practicing routine prevention treatment for dollarspot you are getting some benefit for large patch. It also occurs to me that perhaps we could take a material like Crag 531 and modify it and perhaps come up with a fungicide that will control both diseases.

This is pythium. Pythium, as you saw it last summer, usually starts out as small spots about the size of dollarspots and it usually is a little browner and, if there is any depression on the green, it starts to run into streaks from the high points to the low points. But this is pythium and that is what ruined a good many greens in Pennsylvania last summer. Notice how much the spots look like dollar spots.

This is what happened to Joe Valentine's greens just before he was going to put on a tournament. This is what he had to do to get a good surface on his greens. There are two strains of grass here, the colonial bent and the creeping bent. These were all innoculated with pythium. This one was put in a moist chamber at 95°. They were kept in there for 48 hours and, for that time and at that temperature, the grass was killed. These were put into the same kind of chamber at 85°; there was just a little bit of burning. At 75° there was no disease. The pythium which was responsible for this grass, is a very high temperature fungus. It takes 90° to 95° and saturated with humidity to take hold, but when it does take hold, it goes very fast.

This one was in the moist chamber just 24 hours. At

the end of 12 hours, we opened up the chamber and put a fungicide on, but it didn't do any good. I don't know how to use the fungicide that controls pythium outdoors. Pythium is a disease that doesn't strike every year. The only thing we have been able to do with it so far is to check up on temperature relationships. This whole area is large patch. Inside it is this peculiar thing. I don't know what it is and neither does anybody else. It is something new.

-o-

CONTROL OF INSECTS AND OTHER ANIMALS

J. C. Schread
Connecticut Agricultural Experiment Station

Looking back over the last 7 or 8 years, we realize that a large number of effective insecticides have been developed for the control of insects. Perhaps we are not going too far if we say that we may have proceeded just a little bit too fast with certain chemicals, overlooking some of the more fundamental details concerned with their use. However, the fact remains that in America we are out and beyond other nations in the control of pests. Today we are concerned with a special group of insect pests-- to wit, those that destroy turf.

In the early part of this century, there were very few insecticides. In fact, there was very little known about the control of insects. At first there was fish oil soap. A little later lead arsenate and nicotine sulfate were introduced. In 1941 DDT became a reality. In 1943 the United States Department of Agriculture used it for the first time for the control of white grubs.

First slide. There are a number of species of white grubs, including the Japanese beetle and the Asiatic beetle. This picture was taken at a golf course in Connecticut in 1941 prior to the introduction of DDT. Grub populations (exceeding 150 to the square foot) were not uncommon at that time.

Next slide. The injury to turf in golf courses was extensive. Lead arsenate was for years applied to infestations at the rate of 450 to 500 pounds to the acre. It was slow in action, requiring anywhere from a few months to virtually a year to achieve good con-

trol of a grub population. Notice here, Gentlemen, that the green was well protected by insecticides, while in the foreground the turf was not and in consequence was destroyed.

In 1946 we in Connecticut used DDT for the first time at the State Experiment Station in New Haven. It was applied to turf at the rate of 250 pounds of 10% dust to the acre. Incidentally, this level had been established by the United States Department of Agriculture as satisfactory for the purpose.

Next slide. This fairway was treated with DDT May 15, 1946. The grub population at the time of treatment was of the order of 65 grubs per square foot. Within five weeks a reduction in grub population of 75% was attained.

Next slide. On the other hand, this fairway was not treated, consequently in the fall of 1946 with a grub population of 2.9 to the square foot in treated turf there were 125 to 140 grubs per square foot in this untreated turf. In 1947 the grub population in the fairway that had been treated was down to approximately 1.8 per square foot, whereas in adjoining areas there were 65 to 75 grubs per square foot. In 1948 the grub population in the treated fairway was nil, at the same time the population in the untreated turf averaged 11 to 15 per square foot. In the autumn of 1949, over three years after treatment, there was an occasional grub in the treated plot and 5 to 6 per square foot in untreated areas.

Let us go back to 1943 for a moment and review what has happened in the last 7 years so far as the Japanese beetle is concerned. That year was rather dry. The rainfall during the critical period of the Japanese beetle life cycle, which is July to the middle of September, was about 10 inches. In the following year, 1944, it was down to 6 inches. As a result there was a general drop in grub population.

In 1945 the rainfall was up to about 13 inches during the critical period and in 1946 and 1947 it rose to an average of 17 inches. During the latter years we began to see a lot of damage by grubs to turf, not only in Connecticut, but also in other beetle infected areas along the Atlantic seaboard.

By 1948 the rainfall had dropped down again to about 14 inches and in 1949 it was down to 10 inches. What to expect this coming year (1950) is a matter of spec-

ulation and I am not one to give a guess. In any event, however, during the spring and early summer the grub population will in general be very low. Rainfall throughout the summer months will largely determine the status of the beetle during the remainder of the year.

In 1947 we began using a few of the more recently developed chemicals-- Chlordane, Toxaphene, Benzene hexachloride and Parathion for control of grubs. Toxaphene was applied to turf experimentally at five different levels; that is, 8, 12, 16, 20, and 24 pounds of actual toxicant to the acre for the control of Japanese beetle larvae with excellent results. Benzene hexachloride was used at from one to five pounds and Chlordane at 8, 10, 16, and 24 pounds with rapid reduction in population where the materials were applied.

In May, 1947, in plots where Chlordane was used experimentally, grub populations varied from 25 to 117 grubs per square fppt. In four weeks reductions in populations of the order of 88%, 93% and 98% respectively were obtained. In the summer of 1947 Chlordane was applied to a heavy grub population at the rate of ten pounds of actual toxicant per acre using a 5% dust for the purpose. The dust was mixed with Milorganite to assure better distribution and more even coverage. Reduction in population of 95% was achieved in two weeks.

Next Slide. In the fall of 1947 the New Haven Park Department was confronted with a problem of grub control in one of its football fields. The population averaged 85 per square foot. Of course, the question arose relative to what might be used to destroy the infestation. It was suggested that Chlordane be applied (and it was) at the rate of 200 pounds of 5% dust to the acre.

Next slide. At about the same time there existed in a nearby town a privately owned athletic field heavily infested with grubs averaging 75 per square foot. This field was not treated when it should have been. Consequently, as a result of excessive grub injury, complete re-seeding became necessary the following spring.

Next slide. Ant control by Chlordane. The cornfield ant is sometimes quite a nuisance on golf course greens. It may be controlled by using Chlordane either as a spot treatment or complete turf treatment.

By the spot treatment is meant that the toxicant may be applied as a 40% or 50% wettable powder at the rate of about 1/8 of a teaspoon per anthill and water in thoroughly. Or the treatment may be applied as a complete turf treatment, treating the entire green area with four ounces of the 40% or 50% wettable powder in 50 gallons of water per 1000 square foot. Follow up the treatment with clear water flushing to achieve good penetration.

In 1949 a turf insect problem arose at the State University at Storrs, Connecticut. A major portion of the campus was heavily infested with the cornfield ant. Treatment became necessary. It was a very dry summer and we had no access to water. Consequently, it was argued that insofar as Chlordane treatments had worked so well when applied as wettable powders, there was every reason to believe it would suffice as a low concentrate dust. Four times as much Chlordane was necessary to destroy the cornfield ant when dust was used than when wettable powders were applied to turf in large quantities of water.

We now come to the control of chinch bugs. Because of dry weather in late season 1948, a serious chinch bug problem arose. Chlordane was applied to infestations as a 5% dust at the rate of 5 pounds per thousand square feet. DDT also was used at the rate of 24 pounds of technical toxicant per acre. DDT 12½%, plus 2½% Sabadilla was applied as a third treatment at the rate of 15 pounds of technical toxicant per acre. Compound 118, which is now known as Aldrin, was used at the rate of 5 pounds of technical toxicant per acre and Chlordane at the rate of 10 pounds per acre. All treatments were made on the same day. It rained hard subsequently. In consequence, we thought perhaps the toxic value of the insecticides for the control of chinch bug was lost. The fact remained, however, that after it had cleared on the following day, an examination of the turf showed that the chinch bug population had been destroyed 100% by Aldrin and Chlordane. Where DDT was used, two weeks seemed necessary before all the adult chinch bugs had been killed.

Last summer (1949) at Pelham Country Club, New York, the question arose relative to what might be done to control chinch bugs infesting all of the fairways. The population was excessive. A large part of the turf was being destroyed. The quantities of 5% Chlordane dust necessary to treat the course could not be delivered in much less than 10 to 12 days. In view of the success with Chlordane dust for chinch bug control it was thought that perhaps the emulsion would also

work well. This type of formulation was applied at the rate of two gallons of 48E (48E contains four pounds of technical Chlordane per gallon) in 50 gallons of water per acre. 120 gallons of 48E were used to treat 60 acres of fairway.

Next slide. This picture shows the turf in excellent condition with almost no chinch bug injury in evidence one month after treatment. We examined the turf periodically until fall, however, and no re-infestation of chinch bugs could be detected.

Experimentally, Aldrin and Dieldrin (497) were used also at Pelham for chinch bug control. Both of these materials are very toxic to all insects to which they have been applied and consequently were used at much lower dosage levels than other insecticides mentioned. Where they were employed at the lowest levels, re-infestation was a little faster than where Chlordane and DDT were applied. However, if the toxic levels are raised, Aldrin and Dieldrin may be expected to provide not only rapid kill of chinch bugs, but also residual action sufficient to keep them out of the fairways for a long period of time.

It was discovered within recent years that the golf courses in the northeastern part of the United States were infested with an exotic earthworm. It occurs naturally in the Orient, including China and Japan. How it got into this country is a matter of speculation. It is believed, however, that it might have gained entrance in plants from which the soil was not removed prior to shipping. In any case, however, it is now known to occur at one or more points from Stamford, Connecticut, down along the Atlantic seaboard as far as Florida. It is more abundant in the New York Metropolitan area. Within 25 miles of New York City there are 32 courses, 25 of which are to a greater or less extent infested with the Oriental earthworm.

Pelham Country Club (where most of the research work was done in 1949) had 18 greens heavily infested as well as several large nursery plots. Among other things, an examination of the soil in all parts of the golf course has shown that the worms were present not only in the greens, but also in the tees, roughs, and fairways. Where the soil was of a sandy and gravelly nature with less fertility and lower moisture-holding capacity, the worms occurred infrequently. In the fairways where it is more fertile and moist, the worm population is greater. However, in the greens where the organic matter is high and the moisture adequate,

they occurred in greatest numbers. Anywhere from 15 to 40 worms per square foot is not uncommon.

The worms vary in length from 150 to 220 mm. and about 5 mm. in diameter. The color in general is a light grass green. The lower aspect of the worm is rather gray whereas the upper surface varies in intensity from a light green to a dark green. Earth castings occur not only once in 24 hours, but sometimes 6 or more times depending on the amount of precipitation or other moisture present. Air temperature and humidity play an important part in the frequency of earth castings. When castings occur three times in 24 hours, it has been estimated (based on the determination of the dry weight of the average casting to be 0,485 gr.) that 240 pounds of earth castings may accumulate on an infested green in a day or 2,065 pounds per acre. It was then estimated that if the castings occur three times a day only once a week during the spring and autumn (a period of virtually 18 weeks) the total weight of castings per year on a 5,000 square foot green would be 2.16 tons; per acre, 18.58 tons.

Earthworm castings are highly nutritious and immediately available to plants from which they may get all of the nutrients that they require. It was shown by Jacobson in 1944 that earthworm castings contain 5% more nitrogen, 7% more phosphate, and 11% more potash than the upper six inches of soil.

The Oriental earthworm is more active at temperatures above 70° F. However, it does cast at 60° F. On February 20, 1949, on the 18th green at Pelham Country Club tremendous casting took place. Incidentally, this green had been treated with Aldrin on December 3, 1948. Despite the treatment the worms cast a number of times in mid-February. In other words, under favorable conditions the worms may be active during all four seasons of the year.

As a result of castings occurring more than once a day, it became necessary for Mr. Twombly to have a man for every three greens or six men poling the greens constantly throughout the daylight hours in order to keep them in a playing condition. Certain greens were poled every 15 or 20 minutes because no sooner were they cleaned than they became covered with castings again.

In 1948 Oriental earthworm infestation occurred on several greens at Woodway Country Club at Stamford, Connecticut. The problem resolved itself into what

might be used for the control of the earthworm there. We decided on Parathion, an organic phosphate which is very injurious to humans and consequently must be handled with a great deal of care. Rubber gloves of a synthetic nature and a respirator were worn by the men applying the treatment.

On the 13th of May, 1948, Parathion was applied to one green at the rate of 21.5 pounds of actual toxicant per acre. Within a few days it was noticeable that the population had been reduced 50% to 60%. On the 24th of May, a second treatment of Parathion was made at the rate of 10.75 pounds of technical material per acre. The reduction after this treatment was of the order of about 75% or 80%. Castings at this time were estimated to be about 20 per square foot in 5,000 square feet. On the 8th of June a third treatment was applied using Parathion at the rate of 30 pounds per acre. Subsequent to this treatment, turf injury developed on the green.

Next slide. This is a picture revealing injury to grass by Parathion. However, within a period of 8 to 10 days the green showed signs of recovery. Despite three treatments the population was still of a formidable nature. In consequence it seemed necessary to apply a fourth treatment. Parathion was used at the rate of 32 pounds of technical toxicant to the acre. In the fall of 1948 it was seen under favorable conditions that there were about 1000 worms remaining in the green. The observation was based on number of castings. In May of the following spring there were only 15 castings and 5 worms. Since then, nothing further has been seen of the population on the Parathion treated green at Woodway Country Club.

In 1948 research was undertaken relative to the control of the earthworms at Pelham Country Club, New York. Some of the greens were treated with various toxicants-- to wit, Parathion, Chlordane, Toxaphene, Benzene hexachloride and a number of others. Most of them worked well. In certain instances, however, there was a small residue of the population present at the close of the season; in consequence we were not entirely satisfied with results obtained in these cases.

It was decided in 1949 that the chemicals should be used as emulsions rather than as the dusts and powders applied in 1948. Chlordane and Aldrin were applied at the rate of 1 pound and ½ pound of technical toxicant respectively per thousand square feet. The results were phenomenal.

These slides show No. 18 green at Pelham Country Club. They illustrate the difference between the population before a treatment of Chlordane was applied and again at a later date. The reduction in population in 6 to 8 weeks was almost complete. All of the surrounding area is heavily infested, but the green is virtually free from infestation.

-o-

SOIL CONSERVATION

Fred L. Bull, District Conservationist
Soil Conservation Service

I expect all of you have soil conservation districts in your home states and that they operate very similarly to the way our districts are operating here in Maryland. We, in the Soil Conservation Service, lend our assistance to the district supervisors of the soil conservation districts and help them in combatting their soil erosion problems. Now, we find that a lot of the farmers with whom we work think that once a field is established in grass, they don't have to worry very much about erosion from then on. But you people all know that it is just as important to manage that grassland properly as it is to get it in grass.

The sheet erosion that occurs on slightly sloping land sometimes, unless brought under control, soon develops into a gullied condition. Here is a condition that we found in Howard County last summer on a little trip out there with the State Soil Conservation Committee. Here is a field in Howard County which had been seeded to alfalfa just a week or so before we got there. The farmer hadn't reached the point where he could see a need for erosion control practices on his land, other than seeding. He had plowed, prepared and seeded the whole field without any regard for the contour or the need for strip cropping. Down through the waterway which should have remained in sod, all the topsoil was washed out and across the highway and into a neighbors pasture field. This not only meant a loss to this farmer, but also damaged the pasture land belonging to his neighbor.

We have the problem of not only soil erosion, but sometimes we find that it is necessary to drain land which is too wet for profitable use. Here is one such

field where drainage practices are being worked out.

Stream bank erosion control may concern some of you people. We have hundreds of acres of land in the Districts which I work that are ruined by the meandering of streams. This stream starts to go over this way and gradually eats out the pasture field and then bends over to the other side, doing the same damage. We are working on that problem. Basket willow is being used to stabilize stream banks.

What is the plan of approach for these farmers who request assistance from soil conservation districts? Well, we feel that the first and most important thing to do is to have the farmer get to know his land and have us get to know his land with him. In other words take an inventory of what he has to work with. If you go out to build a house, you look around to see if you have the necessary materials with which to work. If you are using land, you need to get to know that land.

You must determine whether you have the right type of land to produce the kind of crop you have in mind. So that is the first step in giving assistance to land owners in these Soil Conservation Districts.

We make a soil survey of the farm and prepare what we call a land use capability map, classifying the land into various classes. The green land is class one land, which means that it is more or less level land that is not subject to severe erosion and can be planted in row crops several years in succession. Class 2 land requires a little more control, such as contour farming and perhaps some other practice.

This is the kind of land we like to see on farms that are trying to produce good pasture and control erosion on the crop land. Contour pasture furrows often help to improve the turf by holding the rainfall and allowing it to soak in for the benefit of the grass.

This farmer is mowing his pasture. This practice eliminates the mature grass and weed growth thus improving the desirable grasses and legumes. You will note that contour pasture furrows have been plowed in this field and that the mowing is done parallel to the furrows rather than across them.

The matter of erosion control is pretty important from a great many standpoints. One very important reason is to keep the silt out of our harbors and reservoirs. Another erosion problem that I want to point out is the problem of highway banks. Some of our highways

are being constructed, leaving the banks almost perpendicular and allowing them to crumble down into the highway ditch. When we tie our land down with vegetation, as you see here, it doesn't get away from us so fast. This particular farmer applies contour strip cropping to all his land and uses an alfalfa mixture on some of his steeper land, and it really keeps it under control. Farmers applying this practice are saving the plant nutrients and are getting very good results.

This picture demonstrates what contour strip cropping does. The rows, all being on the level, are holding the rainfall-- each row serving as a little dam. This is one of the early farms to start with soil conservation practices here in Maryland. Contour strip cropping was applied here. Diversion terraces, as you see here, quite often can be used to divide long slopes into short slopes in order to establish permanent vegetation on badly eroded land. Here is a diversion terrace under construction. The district supervisors are assisting farmers by making arrangements for a contractor to build diversion terraces.

Farm ponds are an important part of a conservation farm plan. They are being used for a good many purposes, for water storage, for fire control, for recreation, and for food production. I might say that it is just as important to know your land when you are thinking about building a farm pond as it is for any other purpose. We had the misfortune of assisting some farmers with the farm ponds and they wound up with only a hole in the ground because we and they had not determined definitely that they had soil which would hold water. This is one, however, that doesn't fall into that category. This farmer told me the other day that he had caught about 300 fish from his pond.

This is multiflora rose. It is a very thorny type of rose and is being used extensively as living fences. It is planted about 12 or 15 inches apart in a row. It spreads about 10 feet wide and is about 7 or 8 feet high. Most of you probably heard of the Thrasher farm demonstration which was conducted here in Maryland in August, 1948. At that time we undertook to rebuild a farm in one day. These are a few of the buildings. The owner had not seen fit to apply modern farm practices, so the land was pretty badly depleted. We built a pond, built a new barn, made contour strips, put in fertilizer, and did all those things in one day.

In closing, I would just like to say that any of the soil conservation districts will be glad to give you any assistance that comes within their category.