SIXTH ANNUAL TEXAS TURF CONFERENCE

TEXAS TURF ASSOCIATION
AND THE
A. & M. COLLEGE OF TEXAS

1951

Compiled Courtesy of

WEST POINT PRODUCTS CORPORATION

West Point, Pa.

WELCOME

R. D. Lewis, Director
Texas Agricultural Experiment Station
College Station, Texas

You are all welcome and you know that. Texas A & M College is a public institution. The Texas A & M College System serves the public in terms of research and education.

Some of you may not know very much about this College and its immediate connections. The A & M College of Texas is one of nine parts of a system, established in 1948 under the name - The Texas Agricultural and Mechanical College System. There are three other colleges in the system -- one at Prairie View and two junior colleges, Arlington and Tarleton. Then there are five services in the system -- the Texas Agricultural Experiment Station, The Texas Agricultural Extension Service, Texas Engineering Experiment Station, Texas Engineering Extension Service and the Texas Forest Service. Those four colleges and the five services constitute the Texas A & M College System, which has representatives in every county in the state and is providing service and information in them.

You will remember that in January of 1947 we had our first Texas Turf Conference and in 1951 we are having two conferences. At the time of the first turf conference there was formed the Texas Turf Association, primarily because of the common interest among groups that were concerned with turf on golf courses, lawns, parks, along highways and on playing fields. The association had a very definite objective of trying to encourage research with turf grasses. So in 1947 the association set up a program to attempt to initiate support of research. The officers and directors set out to raise annually $3750 for research. This last year there was contributed $1534 toward that research program. We are then a long way from the goal. But I am very happy to say that on small sums rather significant progress has been made. I give our people who are engaged in these particular projects a lot of credit. Rather than waiting to have the funds available, they have gone ahead and worked. That is one of the marks of a good research man. They have really done far better than our expectations.

Jim Watson has had a number of offers to go elsewhere at higher salaries but because of his interest in this

work, he has stayed here and not only leads the research work but is rendering a lot of services to those having turf problems.

During the last three years we have instituted in the Texas Agricultural Experiment Station a New Plants Project. Last year we brought into this state something like over 2000 new strains of plants, including many grasses. Very few of those are going to be good, however.

This past year there was initiated on the national level a National Grasslands program. I happen to be on the national steering committee which seeks to focus attention on grasslands, largely from the standpoint of agriculture. Not much has been said in this committee about turfs of the type in which you are especially interested. However, it will give stimulus to research in the utilization of turf for playing fields and for covering up soils along highways and things of that sort. This National Grasslands program is a joint undertaking between the Land-Grant Colleges of the country and the United States Department of Agriculture. Associated with it are representatives from a great many industries. It is administrated more or less by this steering committee, on which there are four directors of state experiment stations, four directors of state agricultural extension service and a counter part group from the United States Department of Agriculture. It has had five meetings to date. It certainly is leading to a much better understanding of the place of grass in our national economy.

Many of you will be interested to know that one of the specific projects of this National Grasslands Steering Committee relates to the International Grasslands Congress to be held at Pennsylvania State College in August of 1952.

Another undertaking of that national grasslands committee is a movie. Some of you remember the movie, The River, - This one on grass is to be somewhat similar. It will be available for showing to general audiences to give people a better understanding of grass in the economy and life of the nation. We have gone over the script for the movie and now it is being developed at Washington. It will not be available by August as we had hoped.

I have commented on a few general things that I thought might be of interest to you. May I repeat what I have said a great many times - Without the background of facts, new materials, new grasses, new understandings

that research can bring to you, we can't expect to have good turf generally. We must learn "Why", "how" and "When" from investigations in order that we can have good lawns, parks, highways, golf courses, football fields, airports, and cemetery coverage. Certainly after food, turf is the most nearly common link between town and country. Grass should be taught more in public schools. Botany and biology classes should use it as the finest kind of illustrative material. Grass is truly a common link between town and country.

A few colored pictures now that I have taken this past year of grasses. Here are a few grasses that are native and some that are introduced. Here are pictures of two grasses that are very important agriculturally in Texas. The first is Rhodesgrass which was widely used in the state but which is very susceptible to a scale insect. The next grass -- Angeltongrass -- is highly resistant to that insect.

The next three pictures show you different strains of bermudagrass in the plots that Potts and Watson have established. These differences are very striking, and show that better bermudagrass can be made available for lawns and playing fields of Texas.

May I say again that we are very, very happy to have the opportunity again of being hosts to this group, who are so greatly interested and are working with turf and know what it means to the beauty, comfort and joy of the people of this state. I am glad you came back to Texas A & M for this conference.

-o-

DEVELOPING A TURF GRASS

E. C. Holt
A & M College System
College Station, Texas

Grass improvement only dates back to the late 1890's. Actually not very much work was done prior to the 1920's. Grass improvement has not progressed as rapidly as improvement of many of the field crops and turf grass improvement has lagged even further behind, Until about 1940 turf grass improvement was limited mainly to the collection of types within the three bentgrasses, creeping, colonial and velvet, by the USGA Green Section.

Breeding programs may be very simple or quite complicated depending upon the material at hand to work with the objectives of the program and the method of utilizing the final product. The fact that most of the fine turf grasses have been utilized vegetatively simplifies the breeding program to some extent. The variability among seedling progeny does not have to be a concern of the breeder. If a plant is found with the desirable characteristics, it can be increased and used in that form without worrying about what the turf produced from seed would look like.

Since most of the work with turf grasses has consisted of the collection of types followed by evaluation studies or testing of the strains, I would like to limit my talk mainly to this type of program, which we call strain testing or strain evaluation. This type of program has been quite productive with creeping bentgrass and shows promise of being productive with bermudagrass also. Such a program begins with the collection of material from putting greens, fairways and other types of turf. I am sure that all of you have noticed spots developing in greens which appear different to the remainder of the green. This happens especially in seeded greens. These spots may differ in color, texture, density, disease resistance, drought tolerance, ability to compete with weeds, response to fertilizer or other chemicals and possibly in other respects also. More than 100 types of creeping bentgrass have been collected in this manner. A sod plug is removed from the spot and increased vegetatively and used vegetatively. The strains obtained in this manner are studies for the various characteristics just listed. I have some slides demonstrating some the characteristics of the bentgrass collections and some of the progress that has been made in obtaining superior turf strains by this method.

The same procedure can and is being used with bermudagrass. Bermudagrass greens show the same type of variability as creeping bentgrass greens. A program of collection of Bermuda types was started here in 1949. Some of you have seen these strains in the turf plots. I have some slides which will show the progress that has been made with this program.

This type of program, that of collecting and evaluating, is the basis of for any breeding program, but it is capable of producing fairly rapid results where the material can be used vegetatively as is true with the turf grasses in general. If it is desirable to reproduce the strain by seed, further evaluation and selection is necessary. This point will also be demon-

strated with slides. Slides shown.

From these slides I hope you have seen the progress that is possible from a program of collecting and evaluating strains. The development of a new turf grass does not necessarily stop here however. If the desirable characteristics are not found in one strain, two or more types are crossed or hybridized in the hopes of obtaining the desirable combinations from the cross. This type of program was discussed with you last year by Dr. Glenn Burton. Tift 57 is an example of the results of such a program. If you noticed in the bentgrass slides, one strain was disease resistant another of a desirable color, and still another resistant to weed invasion. A program is now under way in the North Central States to combine some of these desirable characteristics into one strain.

I would like to leave with you these thoughts; the development of a turf strain takes time, sometimes many years depending on the type of program that has to be followed and that strains developed or tested in one area may or may not be superior in another area. U-3 and Tift 57 Bermuda are good examples of this.

-o-

HOW CLIMATE INFLUENCES THE MANAGEMENT OF TURF GRASSES

Albert W. Crain
A & M College System
College Station, Texas

TEMPERATURE

Temperature influences every chemical and physical process in plants -- solubility of minerals;absorption of water, gases, and mineral nutrients; movement and "digestion" of moisture,gases and nutrients; as well as growth and reproduction.

Unlike warm-blooded animals,plants have no means of controlling temperature independent of environment.Unless you and I (example of warm-blooded animal) are ill our temperature remains about 98.6 degrees F. day and night, winter and summer. Generally speaking, plants and plant parts have about the same temperature as their surroundings.

For each species or kind of plant there is an optimum temperature as well as one too high and one too low for growth. As you are aware, we are classifying our turf grasses into cool season and warm season plants. The figures in Table 1, are general for all plants, it shows the temperature and growth relationships to cool and warm season plants. We can think in Texas of two examples to use with the two types; bentgrass, a cool season perennial; ryegrass, as cool season annual. Bermudagrass as a warm season perennial; crabgrass as a warm season annual.

Table 1. Temperature and growth relationships to cool and warm season plants

	cardinal growth temperatures		
Type of Plant	Minimum*	Optimum	Maximum
Warm Season	59-64Deg.F.	87-96	111-122
Cool Season	32-41	77-87	88- 98

* Temperature range in which growth ceases.

Some things to note in relation to Table 1. include; (1) There is a greater spread between minimum to optimum than from optimum to maximum. (2) For each 18 degrees up or down from optimum the growth rate is cut in half. (3) The optimum represents temperature at which most rapid growth takes place and is not necessarily the best in which to grow plants. (4) The optimum temperature varies with the stage of growth of the plants. (5) The root system grows at a lower temperature, in general, than does the topgrowth. (6) Rate of growth, primarily controlled by temperature, influences resistance or susceptibility to insects and diseases. (Too, insects and diseases have minimum optimum and maximum growing temperatures similar to our turf grasses, actually many of our turf diseases are a lower form of plant life and insects are not warm blooded animals.)

Low Temperature

Freezing and thawing temperatures may have an indirect effect on plants - breaking roots, rupture of cell walls and structure and other ill effects. The main

all effect of temperatures on the low side is sudden changes. This is related to early fall or late spring frosts. Plant sap is primarily water: when water freezes it expands (what about your water pipes, car radiator and so on). It is no wonder that plants are killed occasionally by low temperature.

High Temperature

The effects of high temperature are fewer but more exacting. Ryegrass goes out in a relatively short period in the spring because it has reached a stage of maturity (influence of temperature) plus heavy rust infestation-plus the fact that the plants are killed by the high temperature. Above optimum temperatures on bermuda cause short stubby growth, slower rate of growth. Too, excessive temperatures cause more evaporation of soil water in addition to excessive transpiration ("sweating") of the grass. The demands of the tops or leaves for water is so great roots can not supply the needed water, this results in dwarfing growth or in extreme wilting and dieing.

Soil Temperature

1. Soil derives most all heat from sun, very little from decomposition.

2. Heat energy (sun rays) not all absorbed. On a wet, bare soil 7 to 10% reflected back; on a dry, bare soil about double this amount; and on a soil with turf crop about four times this amount.

3. Absorbed heat is dissipated in three ways; evaporates water; heats soil and air; and part is re-radiated.

4. Dark-colored soils absorb more heat than light-colored soils. The darker the color of the soil the higher will be the temperature in the soil. A difference of about 20 F exists between dark and white surfaced samples of the same soil.

5. Southern slopes, in our hemisphere, are warmer than northern slopes,, because heat rays strike the

6. As soil drainage is improved soil temperatures become higher, due to less heat used to warm up and evaporate water.

7. Vegetation reduces both daily and seasonal fluctuations. The heavier the vegetation or mulch the smaller the fluctuations.

8. In clear weather, air temperature over a turf is higher than soil surface temperature during the day, but lower during the night; on a bare soil, the reverse is true.

9. Overgrazed pastures freeze deeper than those properly grazed. Too, frost or ice disappears earlier from properly grazed areas. This is related to height of cut on turf.

WATER

Under natural conditions water is next in importance to temperature in determining where plants are adapted (bermuda grows on parks, cemetaries and fairways in East and Central Texas, Buffalo grass is West Texas). Under the unnatural conditions of a golf course or other watered area we have upset natural conditions. We modify soil temperatures with water and thus grow a northern grass (bent) in Texas.

Excessive water, however, drives air out of the soil, lowers the temperature, causes lush weak growth susceptible to insects, diseases, sudden temperature changes and excessive mechanical injury.

In terms of structures, a plant is a water structure, in the same sense that a house built of brick is a brick building -- 70 to 90 percent of a growing plant is water. Most of the water is taken into the plant through the roots. Plants use air also, fact is roots require as much air (oxygen) as leaves. When too much water is applied on turf, air is driven from the soil and plants suffocate, develop roots in or on surfaces to get air. They are weakened. In the case of excess water in soil, plants lack air, must dispose of excess water, (overworked) thus become sick and can't take in enough nutrients. Actually, in a water soaked soil nutrients become unavailable.

LIGHT AND GROWTH

Plants vary in their needs for sunlight. Cool season plants require less than warm season. When insufficient light exists long flimsy stems and leaves result. It was pointed out regarding high temperatures - and this is related to excess sunlight __ short subby growth results.

Sunlight is necessary to develop the green pigment (chlorophyll) which is essential in food manufacture and growth. Growth would not occur otherwise.

Light also influences reproduction but in turf management we are not concerned with seed production. We would like to prevent maturity, we can't, so no need to discuss this phase of growth and light.

-o-

HOW MANAGEMENT OF TURF INFLUENCES DISEASE INCIDENCE

O. J. Noer
Milwaukee Sewerage Commission

What I have to say must, of necessity, be directed toward bent. After a season such as the past one in the southwest it is just as well that I do. Oklahoma and North Texas experienced Kansas City weather except that temperatures were higher. Under conditions like that some trouble is inevitable. Yet I don't think you should let one year out of 30 discourage you because the odds favor better weather in years to come.

I would rather have a mediocre grass in capable hands than the best grass in incompetent hands. I recall a club in Oklahoma that never had grass on their greens during July and August. Since the present superintendent assumed charge greens have never been bad at any time. We have equally bad seasons in the north. The last bad one was 1948. When we get weather of that kind, we must expect some trouble. Trouble during one bad season does not justify throwing everything we know into the disgard.

Fungicides for the control of turf diseases are needed and they have a very definite place in the turf maintenance picture. Some of them are better than others particularly for certain purposes. For example, if we have copperspot, we use PMAS or a material of that kind for its control because we know some of the other fungicides will not do the job. Yet even the best fungicides, - I have found in my travels around the country are often condemned as no good. Yet across the street the neighboring course has the same soil, same kind of grass, same climate, same weather and disease is not bad and early controlled. Nobody can tell me that it is anything but the management factor that spells the difference. In talking about turf disease we stress the matter of fungicides and control measures too much, and overlook the matter of maintenance which is even more important.

The first thing to decide is whether the disease is the primary or the secondary cause of loss of turf. In other words, sometimes we see leafspot and blame it for the loss of Poa annua in greens. Yet that isn't always the primary reason for the loss of the grass. The leaf spot attacks the grass because of some other factor that has made it weak and susceptible to leafspot. That does not mean that there aren't times when leafspot is the primary reason for loss of grass. In Alabama last Saturday and Sunday and also in New Orleans I saw leafspot injury to bermuda which I think was due to weather conditions and am convinced it was the primary cause for trouble of the bermuda. But we must not forget that at times the disease is secondary to something else.

I recall many years ago visiting a course in Chicago. I was asked if pythium wasn't responsible for the loss of the grass. Conditions were right for it to work and I presume it was the immediate problem. Since there is no cure for pythium there is no stigma from the standpoint of the man in charge of the turf. The grass on that green was Virginia bent which is very susceptible to this and other diseases. The soil should have been used to make brick instead to grow grass and the green was located in a shaded area without any air drainage. Rather than worry about the immmediate problem of pythium it seemed to me that they should worry about several other more basic problems so far as maintenance is concerned. I have seen that green every few years in the past 20 years and since the green was changed and soil condition corrected, there has been no loss of grass.

Most of the turf diseases are caused by fungi. The infectious diseases which trouble man are caused by bacteria. Fungi are simple plants and are of two types. There are the socalled parasitic fungi which produce disease and there are the saprophytic types which live on the dead organic matter in the soil only and are responsible for its decay and the release of many plant food elements. Just because you see white fuzz, don't think it is necessarily proof that the organism is a parasite.

The fungi have requirements for growth just as plants have. Growth is affected by temperature. Some grow best at low temperatures, such as snow mold. Dollarspot is usually a cooler weather disease, and brownpatch comes in during the hot humid weather.

Soil reaction is also a factor. Sometimes lime does as much to stop the activity of the disease organism

as a fungicide. In Philadelphia when brownpatch gets bad and the fungicides are not working too well, Joe Valentine uses hydrated lime. Usually it does a better job under those conditions than a fungicide.

Fungi must have a plentiful supply of moisture. The simple example is bread. Stale bread never molds -- but fresh bread does. The differences between the two is only the moisture content. That is why sopping wet greens present an aggravated disease problem.

Grass susceptibility is also important. We know that certain strains of grasses are far more susceptible to a particular disease and that others are more resistant. For example, Seaside bent is not looked upon with too much favor in Canada where trouble is apt to be snowmold. Seaside is very susceptible to this disease. Some of the other grasses are more resistant to it. Washington and Metropolitan differ very remarkably in their resistance and susceptibility to brownpatch. Washington is quite susceptible to dollarspot, and more resistant to brownpatch; whereas Metropolitan takes brownpatch and is quite resistant to dollarspot.

Grasses may not always retain their ability to resist attack. There is always a race between the plant breeders to keep ahead of diseases. A variety of wheat becomes less resistant or the type of disease becomes more virile. This past summer was the first time I have seen any brown patch on Arlington bentgrass. I still think Arlington is a good grass and feel sure that its resistance will always stay at a high level. Those of you who have had experiences maintaining grass know that for the first several years after a green is planted, you have less trouble than you do when it gets older. I saw some plots of Washington strain of bent that looked rather sorry. Anyone who saw them would not want this grass. Yet Milwaukee Country Club has 19 greens of Washington bent that have been in perfect condition for 25 years. It seems to me this matter of management is also an important factor with any of these grasses.

The character of growth on the green is very important. If the grass is allowed to develop an excessive surface mat, then dollarspot is more serious, and does not respond to the fungicide nearly as well as when the turf is tight. One of the reasons for that may be that the fungicide stays near the top and the organisms continue to work underneath. The disease scars become pitted and interfere with putting quality of the green. An excessive mat affects the depth of the

root system. A heavily thatched turf seldom has deep roots and when that happens localized dry spots develop and is followed by scald.

Mention is made of the kind of soil. Although a factor it is a minor one. Climate and weather conditions are even more important along with the kind and strain of grass.

A high content of organic matter tends to aggravate certain types of disease. I have in mind several courses in the state of Connecticut. These two courses have snowmold in seasons when nobody else is troubled. It is my belief that the reason for the trouble is the fact that they want to keep a nice spongy surface so with any kind of shot the ball stops. This has been accomplished by the excessive use of humus. As a consequence, when the greens come out of the winter, the soil stays excessively wet and provides the moisture that is needed by the snowmold organism. On the other courses with a lower humus content of the soil, the tendency is for greens to dry out faster and this lessens or stops the activity of the disease. I am sure that I am correct because since these two courses have changed the character of the soil used in the top dressing mixture, snowmold has become less troublesome.

I have made mention briefly of lime and related soil reaction. There are times when lime tends to reduce the activity of these diseases. I am going to show you pictures to bear out the statements that I have made.

When scald appears on the surface, it is evidence of too wet a soil for one thing and too thin a turf. The thinning may be due to too much water or not enough oxygen in the soil. It may have been caused by repeated attacks of brownpatch which defoliates the plants and exposes the soil surface to the light. When there is an excessively wet surface without a dense cover of turf to exclude the light from the soil surface algae is bound to appear. Then as drying occurs a black skin-like covering is left on the surface of the green. It seals the surface and impedes recovery of the grass. A little hydrated lime, possibly 5 to 6 pounds per 1000 square feet, will check the algae, and speed recovery of the grass.

In 1948 I was in Pennsylvania and was told that Tulsa, Oklahoma, was trying to get me on the phone. They caught up with me at Lancaster, Pennsylvania. I was asked to take the first plane to Tulsa because the

greens were going bad. I refused because I knew of no wand I could wave over the greens and bring them back. I asked if weather had been hot, and wet. I was told there had been downpouring rains. I told Bill he should go to church and ask the Lord to stop the rains and lower the temperatures a bit. If there was algae on the greens it was suggested that hydrated lime be used sparingly even though the reaction was above 7. When I went to Tulsa three weeks later, I was told that the recovery after the light applications of hydrated had been nothing short of marvelous.

Overdoing potash, tends to aggravate the clover problem. On the other hand maintaining a proper level of nitrogen, goes a long way toward overshadowing its stimulating effect on clover. I emphasize potash so far as greens are concerned, in contrast to fairways, because it is the one place where you are a farmer. By removing clippings greens are cropped whereas on the fairways the clippings fall and decay, their phosphorus and potash are released and returned to the soil in forms which the plant can utilize.

I haven't yet seen a green that wasn't pretty well supplied with phosphorus. Many of you are making low-grade phosphate mines out ofthem. You are putting on so much phosphate fertilizer that we have found as much as 3,000, 4,000 and 5,000 pounds per acre of phosphorus by the Truog method; when we think 200 to 300 pounds is a good supply. Where soils are on the alkaline side the excessive use of phosphate aggravates ion chlorosis.

Nitrogen feeding is the key to the whole problem of grass management on greens. Nitrogen is the sales promotion engineer of the fertilizer industry. Put it on and the grass turns green and starts vigorous growth. This is not true of phosphate or potash fertilizers. Nitrogen and water are the two things that tend to make plants soft and succulent. A high level of nitrogen and a good supply of water really turn the trick so far as making grass soft and lush. That is why the lettuce grower who wants to grow an appetizing crop piles on the nitrogen and uses plenty of water. If you want grass that won't stand traffic and wear, that is the thing to do. On the other hand, if you fail to use enough nitrogen and enough water, I know some of the golfers are going to tell you what to do. So it is a matter of balance between the two. We should remember that any time nitrogen is overdone the effect can be partially offset in part by withholding water a little bit.

We know that too little nitrogen, just as well as too much, aggravates dollarspot. When we see greens that are suffering badly for want of nitrogen and see a lot of dollarspot, we know that the fungicide isn't doing the job expected of it because the nitrogen level is too low. At one time dollarspot was always bad in New England when it could not be controlled they thought it was pythium. In many instances their troubles were due to too low levels of nitrogen in the greens. By keeping nitrogen levels where they belong one need not worry near as much about fungicides or about dollarspot for that matter.

Where you are in a place like Dallas and have bent greens, it is my belief that you should try to keep nitrogen levels during spring and fall at a point where they tend to reduce dollarspot, and then in midsummer let the levels drop a bit and keep the grass barely growing. Then brownpatch will be less troublesome. Should scald develop it is notime to use a lot of nitrogen. With no roots and little grass there is nothing left to utilize the nitrogen. The better plan is to let recovery start before encouraging growth of the grass.

Water is important also. It doesn't matter much when you water if the tendency is to over water. Too much water keeps the grass wet and is the best way to encourage disease. That does not mean that you should let the greens dry out. The important point is to use the proper amount of water. Then there is evidence to support early morning as the best time to water. I don't think that makes much difference in some of these areas where there is little or no humidity. Even though the greens are watered during the night, the moisture level in the atmosphere is so low that the surplus water will evaporate rather rapidly. However, in periods of high humidity which tend to check evaporation, then nighttime watering tends to aggravate disease. If the turf is watered in early morning, the droplets of dew are destroyed and pass down into the soil. Early morning watering dries the grass foliage and thus reduces disease.

I didn't mention anything about nutritional diseases such as iron chlorosis. It is a yellowing of the grass which is due to a temporary inability of the grass to satisfy its requirements for iron. The amount required by grass is very small and every soil has an ample quantity yet there are times when a deficienty occurs. It is usually associated with a fairly high organic matter content of the soil and by over wetness.

Some years ago a man called me from Montana. His greens were going bad. I suggested he send some soil samples to us for testing. We found the reaction to be in the range of pH 7.8 to 8.0. When he called a few days later I asked if the greens were yellow. He replied that they looked like chrome yellow paint. To use a little iron sulfate was suggested not over ½ a pound to the green with a minimum amount of water, not to exceed 25 gallons for the green. He reported that within 12 hours there was a big difference. We must not ignore these nutritional upsets as well as the diseases which result from fungi.

This is a green in Ottawa. The picture was taken in early spring. The grass happens to be Seaside. You can see the line where the fall treatments of Calo-clor stopped. There was no snowmold on the treated portion.

The next is a green in Manchester, New Hampshire, taken about the same time of year. I included a portion of the snow otherwise one might think the picture was taken in July. These greens got a heavy dose of Calo-clor the fall before and yet look what snowmold was doing to the grass. All the greens got 25 pounds per 1000 square foot of an 8-6-4 fertilizer in October. As a result the grass was as green when snow came as it normally is in July. Under such conditions no fungicide could control the disease.

This is a picture of some plots which we operated in Milwaukee. All of them received phosphate and potash. Nitrogen was used on the two far strips, and no nitrogen was used on the front one. Calo-clor was applied once a month at 1, 2, 4 ounces per 1000. The last treatment was made in mid October. Notice that even the check has no snowmold on the no nitrogen strip. On the other hand the grass was so poor that I am sure no golfer would have been satisfied with it.

I am not trying to sell you on the idea of Milorganite rather than sulfate of ammonia. The picture is used illustrate the nitrogen factor mentioned before. When Milorganite was used, there is very little snowmold. The level of available nitrogen because of cool weather there was low enough so two ounces of Calo-clor controlled the disease. Where we put on a lot of immediately available nitrogen from sulfate the grass was soft when it went into the winter. Then even the 4 ounce rate of Calo-clor did not stop snowmold. Where snowmold is a problem we must think about how the grass goes into winter.

Here is a putting green of mixed German bent, in Portland, Maine. Notice how this one patch of bent is relatively immune to dollarspot. The disease is bad everywhere else.

The next picture was taken in the summer of 1948 at Wing Foot located in West Chester County, New York. It is a nursery of bentgrasses with no fungicide on it. C-15 was able to resist brownpatch, but Astoria did not.

These plots were located on a course at Akron, Ohio. I happened to be there just at a time when the weather had been favorable to dollarspot, and then turned hot and was favorable for brownpatch. This is the old Washington strain of creeping bent and this is the Metropolitan. Notice brownpatch is extremely bad on the Metropolitan but not on the Washington, but there is plenty of dollarspot on Washington.

I told you that this summer was the first time I saw brownpatch on Arlington C-1 and here you see it on this green at Louisville, Kentucky. When I was there the temperature was about 95 degrees and the humidity was pretty high.

This picture shows how clover may get a start. Brownpatch was bad and nothing was done to stop it. We seldom worry about brownpatch aslongas there are no recurring attacks which defoliate the grass. Notice the old scar of brownpatch and how clover is present in objectionable amount because of no competition from the grass.

Here is a green in Kentucky. During one of the bad summers with high humidity and down-pouring rains. The copper used in the swimming pool was blamed rather than maintenance. I am sure the small amount of copper wasn't responsible. Loss was more likely due to overwatering.

Here is a bad green on a golf course in Detroit. The injury occurred in 1948. I don't believe the best man living would have avoided scald and troubles of this kind. I think this green should have been used as a bathtub. There isno outlet for surplus water.

This green is in Grand Rapids, Michigan. You can see that the surface looks bad. I remarked that the green probably looked better on Friday thanon Monday morning and was right. The remark was made because there were no roots below the surface one half inch. I knew they had nobody there on Saturday and Sunday. The

grass wilted, turned brown and died. I induced them to drill holes in the green and notice the deep roots they had the next summer. I was told wilting didn't occur as it did the year before.

Here is a picture of the plots at Rhode Island. I think you can see that the foreground strip has a different cast than the ones in the back. The discoloration was caused by copperspot. The only difference in the treatment is the fact that no lime was used on the strip in the foreground, and on the ones in back it was applied at various rates. You can see the difference between a rather severe and a mild attack, due entirely to the use of lime.

Many years ago I was in Philadelphia. I think it was 1928. I stopped at Merion where Joe Valentine had a nursery of Washington bent. I noticed the area on the left had no dollarspot whereas the area on the right had many bad dollarspot scars. Joe told me he hadn't used any fungicide but that a moderate amount of hydrated lime was used on the left half, three weeks before the attack of dollarspot.

Here we see one of the plots at Rhode Island. Dollarspot is very bad. It has been controlled by frequent periodic prevention treatments.

Here is a green in New England. Notice the deep scars from an attack of dollarspot. I think you can see the very heavy surface mat of turf. The green was allowed to become matted and the fungicide weren't doing what was expected of them.

This is a picture Monteith gave me many years ago. The experiment was designed to find out whether continuouse heavy doses of calo-clor would become toxic to the grass. The treatments had been made the year before. A bad attack of dollarspot occurred early the next spring. Notice how the check plots that got no mercury were badly damaged, whereas there was none on the treated plots showing a hold over effect from the treatments of the year before.

The turf on the left received nitrogen at about 1½ pounds per 1000 per month. No nitrogen was used on the right side. You can see there is less dollarspot where the nitrogen was used.

Here is a picture of some plots which we conducted during the war to test various fungicides. We used phosphate, potash on all plots and nitrogen on one series. I think you can see that where there was no nitrogen, dollarspot is much worse.

Here is a picture of nitrogen fertilized plots treated with Calo-clor. Notice that there is some disease on the check of the nitrogen series. The next picture shows the contrast of much more disease on the no nitrogen fertilized check and better control on the other plots. These fungicide treatments were made at monthly intervals. Treatments were 1, 2 and 4 ounces per 1000 square foot. Dollarspot is less severe and prevented by the lighter rates where nitrogen was used in addition to fungicide.

Here is a picture which I took at Los Angeles earlier this month. It is on the turf plots at UCLA. Dollarspot is worse on the low nitrogen level plots and much less severe where nitrogen was maintained at a higher level.

Here is a picture of a green in Milwaukee where we have used soluable nitrogen as sulfate of ammonia as the sole source of nitrogen once a month. The nitrogen does not last long enough to help prevent dollarspot.

Here is a bad green in Cincinnati without any clue as to the cause. But on this one, at the same course the turf grass is yellow in the spots where grass is getting bad. In both instances iron chlorosis is the undoubted cause.

This is another green where grass is being lost, not as a result of disease. It is another instance of iron chlorosis which can be stopped by light spraying with iron sulfate. If something is not done the grass will wither and die. Here again is an instance of chlorosis accompanied by a thinning of the grass. Iron is being sprayed on this green in Miami, Florida, to prevent chlorosis. They are putting on ½ a pound of iron sulfate to the green. This picture was taken 12 hours after putting on iron sulfate. Where the iron was applied the grass is dark green. It is yellow on the unsprayed check area.

Last November I was at Ponte Vedra, in Florida. This was happening to the centipede grass on the fairways. Notice the yellowing. This is another instance of loss of grass from iron chlorosis. Centipede is very touchy so far as iron was concerned. It is a grass that should not get too much lime.

This fairway in the Chicago area was badly hit with dollarspot. Yet the fairway along side of it was almost free. The only difference between the two was

that Frank Dinelli used lime on this one. The lime prevented dollarspot.

The next picture is on another fairway in Chicago and shows the effect of nitrogen level on dollarspot. The disease is confined to the place where the fertilizer spreader missed.

The next picture is Merion bluegrass and was taken last May at San Diego. You might condemn the grass as a result of dollarspot. I don't think it should be used against the grass. Disease is due to too low a nitrogen level and an excessive surface mat of grass.

-o-

PHYSICAL SOIL REQUIREMENTS FOR GROWTH OF TURF GRASSES

J. B. Page
A & M College System
College Station, Texas

I am going to try to discuss this morning some of the physical factors that affect crop production and try to point the discussion to turf so that you will be able to make application to your own particular situation.

The first thing we want to think about is what actually are the requirements that we need from the soil for the plant. Some of these things I am going to discuss may seem rather elementary to you. One thing is that a plant requires support. Plants obviously need nutrients. You had a discussion yesterday of the temperatures particularly as related to climate. Plants and roots require a favorable temperature. The other obvious thing is that plants require water. They get most of their water from the soil. We can greatly affect the water holding capacity of the soil by its management. Lastly plant roots require oxygen. These things are required by the plant.

The next slide brings out the importance of porosity. I feel we think of soil too often as the solid part. We have had a lot of emphasis in the past on texture. After all, let's remember that our roots grow in the pore spaces. The properities of the soil are almost completely dependent on the nature, amount and character of the pore spaces. These pore spaces completely

govern the supply of water and air. Through management we can affect the amount of air and water that is available to plants and indirectly affect the temperature of the environment of the plants through management of the pore spaces as it affects water and drainage. We can change some of the aspects of support particularly those that permit the plant roots to grow and extend freely throughout the soil and come in contact with soil masses. Thus we are primarily concerned with porosity.

There are two kinds of porosity -- textural porosity and structural porosity. Textural porosity is the porosity associated with texture. It is the type you have in sand or in a silt soil. Where you have particles of sufficiently large size so that no matter what you do to those soils (within limits) you still have a certain amount of relatively large pores. The other type of porosity -- the structural porosity -- is important in soils that have a little more clay where, with mismanagement, the clay particles may be packed so tightly together that you have extremely small unavailable pore spaces. You may have the same amount of pore spaces in the soil that you would have in sandy soil but they will be unavailable to the plant for the movement of water and oxygen to roots because they are so small. Where soil structure is good the fine particles clump together into aggregates or crumbs so that the soil is then loose and open and has more of the larger pores which will be available for air and water movement. It is extremely important in managing our soils to keep in mind whether or not we have enough favorable pores in our soils and then get a picture as to whether that porosity is primarily textural or structural because upon that fact will depend almost all of our management with respect to the physical properties of the soil. Usually a sandy soil tends to be droughty, lacking in fertility elements, and doesn't have much holding capacity so far as nutrients and water are concerned. On the other hand, if you have a soil that is primarily one having structural porosity, then that soil has to be managed in such a way that you can either improve or maintain difficult problems for turf management come into that category. If you are thinking about it in connection with the soil you are concerned with, is it primarily textural porosity, or do you have sufficient clay that you are concerned with problems which would be of the nature of a structural porosity?

Pores in the soil may be either continuous or discontinuous. That is one aspect of porosity that hasn't received much attention. Thefunction of pores in the

soil or the way they affect plant growth is controlling movement of water and air. Obviously the wate and air must come in through the surface. Water can move through rather small pores. If your structural porosity. There is the place in our soil management that is full of water. You may have what is otherwise known as an abundance supply. Unless you have continuous pores from the surface down into the deeper part of the soil, you won't have oxygen moving into the soil fast enough from normal root growth and development. We are not yet in a position to do anything in the way of measuring whether or not pores are continuous but there is some very significant progress being made at the present time to develop methods of characterizing soils as to the extent to which the pores are continuous so that you can get an abundant supply of oxygen down into the root zone.

The pores may be either capillary or non-capillary. The capillary are those that are associated with clay particles or associated with soils that are compacted. Soil that has primarily structural porosity may have a favorable porostiy. You may have a soil with 60% porosity. I think Mr. Crain mentioned yesterday that the ideal soil has about 50% porosity and of that 50% volume, we like to have about half of that pore space filled with water and half filled with air. That total figure is set by the texture. If you have a soil with a certain proportion of sand, silt and clay, that sets the total amount of porosity in that soil. To a very large extent nothing you do to that soil in the way of management has much effect on the total pore space but it has a very profound effect on the proportion of capillary pores as compared to non-capillary porosity. There is the place in our soil management picture where we can change the soil properties and in some cases it is very surprising to find out how much change we can bring into our soilproperties and thus change their desirability by simply adjusting the proportion to available capillary pore space.

I have brought along some slides. They will illustrate some of these points about the structure of the soil. Here is a considerable enlargement of an active root growing in a rather heavy soil. It is one that has primarily a structural type ofporosity. The particles dissembled throughout that mass so that they would be in contact with one another, the pore space would be primarily of the capillary type. It would tend to fill with water, oxygen could not get into it and the plant roots would find an unfavorable environment. Whereas in cases like this,if you can see these small

aggregates, you will notice that all of them are clumped together, organic matter is stabilizing and you have produced a favorable type of structural porosity. Notice that the roots are all growing in the spaces. The roots do not grow necessarily on the soil particles. If you get down and look at the roots, you will find them growing in these spaces between the aggregates. The thing we are trying to do in our soil management whether that be choosing our soil in the first place or adding something to change it is rearranging these soil particles and midifying the structure and in turn modifying the pores space. Sometimes with our tractors we tend to forget that we are rearranging these small particles. What we are trying to do with that heavy equipment is to make a favorable environment for this tender root. The requirements of root are rather narrow. They must get nutrients, water and oxygen at the same time. Root channels obviously can't be too large. If they are too small, it might be able to get nutrients for a short period of time but if they remain full of water to the point where the root is deprived of its oxygen it simply stops functioning. Then it is no longer able to assimilate the water and nutrient elements.

You might notice that there are a whole host of root hairs there. Where you have a thin film of water over the aggregates, the pore is large enough so that the main bulk of water has drained out and air has come in. You have a thin film of water and the root hairs are taking up oxygen that is coming in contact with the root from that thin layer. If you have too much water, the root will find an unfavorable environment and if you have too little, it won't grow either. So you must have proper balance.

This shows a situation I am sure you have all seen. It is a place where there have been bluegrass growing in the foreground and alfalfa in the background. This slide was taken in Ohio. Notice the very striking effect ofthe grass roots binding these soil particles together. It has always been said that a grass root of turf was the best way of producing soil structure. It is difficult to see just from working with that how much of that effect was due to the binding action of the roots or whether or not there was actually a high degree of favorable soil structure. That part in the background where it was under alfalfa, and those of you who are familiar with that plant know that it is typical. You tend to have rather loose types of structure. It tends to keep the soil open and permeable. I am thinking of this as you establish new turf and you

may wish to consider what crop you will have there before you plant the crop or make the seedbed.

The next slide shows a close-up of some of that area that had alfalfa on it. You will notice again that that soil is almost completely aggregated. Here you have permitted nature to produce a favorable structure. Conditions would be favorable for growth of plants for making a seedbed or establishing a turf. If you go in there now on a soil that is that condition and start working it down to produce a seedbed, we know we must have a rather compact seedbed for most grasses because they are small but still while we are doing that, we want to keep as many of these aggregates as we can particularly down deep in the soil. Whatever we do there in the way of management and seedbed preparation,we should compromise. From the standpoint of structure we must make a compromise. We must only go as far in the direction of making a finely pulverized seedbed as we have to because this structure has been produced by natural processes and we don't have any good way of producing it except by growth of grass, wetting and drying, or freezing and thawing. It is not a very stable thing once we get it in the soil and we must do everything we can to keep it. We frequently do more to break down the soil in a half hour by a excessive tillage than we will be able to create in several months. So I would like to make that point of trying to consider just how far you must goto make a seedbed fine to prepare for seeding. Try and keep as much of this type of structure as possible. Too many people think it is necessary to pulverize a soil in making a seedbed. Too often when we do that we overdo our seedbed preparation and leave the soil in an unsatisfactory condition as a rootbed. After all, it is to serve mostly as a rootbed. Once the plant gets big enough so that the roots move out into the soil, then oxygen and air are of primary importance.

I have mentioned already the varying proportions of pore space. Here are two situations where you have a virgin soil area that had been under grass for a long period of time and the structure was good. If you could plant your crops on that kind of soil, you would certainly be in good shape. Too often the type of soil we are faced with is this cultivated soil that had corn on it for a long time or some other crop and much of the original favorable porosity has been lost as a result of our failure to use organic matter or our continuous workingand pounding. In turf management I don't think we can say that a clay creates this kind of structure and let it go at that.

Here is the type of situation that is not as severe as many of you have seen. It is where the beating of the rain has broken down the aggregates at the surface. Remember that all the water the plants use and all the oxygen the plants use must go through the surface. We must have the soil on the surface in such a condition so that we have sufficient pore space there for the oxygen to enter thesoil. Any tight layer is the limiting layer that will affect the rate and amount of the water and air that can get down to the roots. Usually we consider that after you have a turf, you have conditions that prevent formation of that type of thing but you can get the same condition where you have too much traffic on it.

This thing of compaction is one that is extremely difficult to handle. I think that is a factor that is too frequently overlooked. We go on the soils when they are wet and use equipment that is too heavy and what we are doing is pounding them down and decreasing the amount of pore space that is available to the plants. Many people have attempted to add materials to the soil to help overcome the effect of compaction. In some cases that is satisfactory. I would like to emphasize that before you can produce very much of an effect on the total textural porosity of the soil, you must have enough material added so that that becomes the main bulk of the soil. People are frequently asking what they can do to a soil to make it drain better. Sand in itself obviously is not porous. A little bit of sand in a heavy soil goes in there and takes up some space and the soil particles may be still as tightly packed as before. It seems that if you are going to have a favorable effect produced by adding sand, you must add enough so that you completely change the character of that soil and make it so that the sand becomes the continuous phase. Thus instead of having a little sand and a lot ofsoil, you have a little soil and a lot of sand. You must have sufficient sand so that the actual sand grains are in contact. They will require a lot of sand.

Question: What about mechanical aeration of the soil?

Deep chislers will often open that deep tight layer. We are faced with the problem of how lasting that will be. The thing that will keep soil open is the same kind of process that will create our structure above. If we have favorable organic matter soils will stay open quite well. Iknow of no other way to open it except by chiseling but you must decide if it is worth the time and money because it may run back again. Some soils will stay open. Let's not put all our depend-

once on tools. The structure is made by natural processes, not by tools. You can use a tool to open it up but you must have conditions favorable for the soil to remain open and porous. If we could get on there some deep rooted legume, that is the best way of stabilizing that structure.

Here is a comparison that would refer to the sort of thing I was talking about before with the use of deep tillage tools. Here are two samples taken out of the same field. Those have been screened out. The textural porosity there is identical. We poured alittle water into the cylinders and here is what happened. The one was stable and the water broke it down very little.

In the other case just doing no more than pouring water on the top, you can see it resulted in a complete breakdown of the structure. You can do that experiment yourself to see if the soil is stable or unstable. Think what would happen to the soil if you would go in and chisel. What would be the point of going to all that time and effort when you have a soil that when it gets wet will run back together? We worry a lot about drainage. Obviously that soil would not drain. We took these two same soils and put them in funnels. In the soil on the left a quart of water would run through in about five minutes. On the one here on the right a quart of water took six hours. This structure stability is important. I know it is difficult to obtain. You can't produce it when you want it. We need to be concerned with the things involved. Sometimes either in your planning system or turf management system, we must recognize the fact that it is important. It may take time to get but it is worth it. I think we will have to recognize that would be costly to get.

Getting back to these original phases, I have already mentioned you can change the texture by adding material but you must add a lot of material. On a golf green you can put on sand but remember you are trying to dilute a few thousand poundsof soil and a thousand pounds of sand won't have much effect. You can change the structure of these methods I have been talking about. Tillage certainly has an effect.

A good deal can be said about water. I would like to point out that water and the oxygen supply are interrelated. Our water supply largely governs the root growth. I would like to say that the evidence is that there is very little movement of water in the soil after the soil gets to its normal water holding capacity. It used to be taught that water rises by capillarity

to supply plants. All the evidence points in the opposite direction. We had better depend entirely on water that goes in the surface of the soil to grow our crop. The evidence shows that the rate of water movement through the soil when it is at its normal water condition is not sufficiently rapid to supply the plants with its needs. In other words, if a plant is going to take its normal supply out of the soil, it will only do it when the roots are spreading through the soil. That can only happen when there is a good supply of oxygen available at all times.

For favorable drainage water must move through the soil. Too often we think about it in terms of engineering. We think that if we put in so many drains, it will take care of our drainage. But for adequate drainage, that water must get down through the soil. In some cases it can be solved by breaking up the pans but it is still true that the maximum effect will only be obtained if the soil stays open and permeable.

Unfortunately we don't see grass wilt as much as corn. We may not be as concious of the extreme stress that plants get into in periods of high temperatures. Most people attribute the wilting of plants to lack of water. The tendency of many practical people is to go out and put on more water. I would like to make the observation that in many cases it is lack of oxygen. If you have a situation where the structure is poor, where the soil is slightly drained, if that wilting is coming about from the lack of oxygen, by putting on more water, you are simply making it worse. We must keep that in mind in choosing how and when to water. It may frequently mean you should not water for a while. It may be related to the rate at which water can move through the soil to the roots.

Finally, this factor of oxygen is essential for root growth and function. Under conditions of low oxygen, roots tend to be stubby and short; with adequate oxygen they are fibrous and tend to grow throughout the soil and thus keep the soil lopen. All of the oxygen that gets into the soil goes in by diffusion. It must difuse into the soil and the carbon dioxide must diffuse out. It takes available pore space to do it. Without the oxygen present in a normal supply, the plant can not take up nutrients or water. Under conditions of low oxygen supply, water absorption is cut down.

Temperature is particularly important to us in the southwest. You had a talk yesterday about the direct effect of temperature on plant adaptatinn. I would like to point out how every significantly high temper-

ature affects the requirements for oxygen. Oxygen is important for all of these things. Notice where you have an oxygen level at a low level, at 64° F. you had 1/3 normal growth. At 86° F. you had 1/16 normal growth. If the temperature goes up 10°, the speed of reaction increases two to three times. If you increase soil temperature, you increase the activity of the roots and its oxygen requirements. You stimulate the growth of micro-organisms. They require oxygen just as much as the higher plant. Some of our soil temperatures in the summer time tend to get very high. If we are going to step up our supply of oxygen, that means that the soil structure must be more than favorable. We must not have any crusts.

In conclusion I would like to emphasize that these points are significant. You must make the application to your own particular case. I think that in turf as well as other crops, it is extremely essential that we obtain and maintain very favorable structure and don't overlook the soil oxygen because it is extremely important.

-o-

BENEFITS FROM AERATION

Tom Mascaro
West Point Products Corp.
West Point, Pa.

This picture was taken about 100 miles south of Mexico City. The boy was plowing with oxen and a wooden plow. We stopped and asked him why he was plowing. The boy said he didn't know; he was plowing because his pappy plowed and his grandpappy plowed and so on down the line. He didn't know the reason why, but he did know that the effects were good. Plowing changes the physical structure of the soil and improves conditions for plant root growth.

Let's look into this thing of air going into the soil. Here is an extremely simple drawing of a plant, showing the movement of air. Carbon dioxide goes into the leaf and oxygen is given off. In the root system oxygen goes into the roots and carbon dioxide is given off. There must be free movement of oxygen going into the soil and of carbon dioxide coming out.

How does air move into the soil? Different factors affect it. One is soil temperature. (This is from Baver's work on soil physics.) Soil temperature accounts for 1/800 of the soil aeration. Barometric pressure accounts for 1/100. Wind action accounts for only 1/1000; rainfall accounts for from 1/12 to 1/16. All the balance is accounted for by diffusion. Diffusion is nothing more than that gases are in a constant state of motion. Gases move under their own power. If you open a gas jet in one corner of a room, you would smell it almost immediately in the other corner. It will move until it reaches equilibrium with the other gases in the air. Gases move into each other until they reach equilibrium. Oxygen from the atmosphere should move into the soil and carbon dioxide from the roots should move out. In a well-aerated soil there is a proper balance of these gases.

Here is a sketch showing soil structure. It illustrates what Dr. Page was saying about good soil structure being 50% voids and 50% solids, and half the voids occupied by water. Heavy machinery or foot traffic compacts soil quickly when soil is extremely wet, because water acts as a lubricant. These flake-like particles fit together and take on this structure. Then you don't get that movement of air through there because it is sealed off. When this happens, the water doesn't go in either.

This work was done by Hannen, showing clay loam and powdery loam soil with good aeration. When it was compacted, it lost 40% of its ability to move air through it. Taking sand, which most people say is good for air movement, and moistening it to 40%, it lost 40% of its ability to move the air. When it was saturated to 80% of its waterholding capacity, diffusion was stopped. Water is a good sealer of soil. Air can not move through the water.

Another reason for getting air into the soil is for the functioning of bacteria. Here we have a list of them. Dr. Hoffer, American Potash Institute, reduced this to terms of fifty 10 pound animals. He said, if you can envision on an acre of turf, 402 ten pound animals all living and breathing, you can readily see the amount of oxygen that is needed for the soil organisms -- this in addition to the plant requirements.

Let's look into some of these tools for aeration. These pictures were taken at Pine Valley GC in New Jersey. Eb Stieniger, superintendent, has a collection of aerating tools that he has picked up over the

years. Turf areas must be aerated without disrupting the use of the area. Here is the potato fork; it is still used today in many areas. Here is the spiker, a disking apparatus and a hollow tine that has a drum. You were supposed to run this over a green and it would core out the soil which then fell into this chamber. This was built in 1926. Here is the hollow tine fork. It is driven into the soil and the soil cores go up into this box and are collected there.

Here is a machine that was made out in St. Louis. It is a piston type that drives hollow tines into the ground. You can see how the hollow tines are mounted on the machine. All these implements and machines were designed with one thing in mind and that was to keep the area in play. This is the drilling machine. It did a fairly good job.

We come into a new line of tools which, as you know, I am interested in. These are the Aerifiers. This shows the curved, open spoons. This is the 1½" diameter spoon. This machine was designed for airfields and pastures to break down through the soiland open it up and cultivate it. Of course, we have the golf course sizes that are hooked up in gangs for fairway work. There is another smaller size. Models cover the whole size range -- all with the same spoon principle. This is the hand-pushed model and this is the fork.

They are all based on "cultivating action". Many of you have these machines so I feel free to say something about their operation. This slide shows what the inch spoons will do on fairway turf. The spoon goes in and makes an open pocket over here. It leaves a small hole at the surface and you are getting "cultivating action" underneath. It improves the soil structure without taking the area out of play.

A test was run to show the effects of different aerating tools. Soil was drilled, hollow-tined and cultivated with the Aerifier spoon. Hot wax was poured into the holes and you can see the difference. Wax spread out in the loose-walled Aerifier hole. It is quite striking.

Another test was made in Louisville, Kentucky, to determine the effectiveness of cultivation. Half the green was hollow tined and half was aerified. These are the hollow tine holes. Roots grow in those holes but they are rather curled up. The wall of the hole is glazed and roots could not move through it. On the other side of the green where the soil was cultivated with the Aerifier you can see the amount of roots that

had formed in the hole.

When we look at greens, we wonder what is wrong with them. I have a little story to tell here. Here is a little bad spot of grass at Rutgers in New Jersey. Ralph Engel is in charge of the plots. On his plots he found this little spot. He couldn't find out what was wrong with that grass. He felt that he should have the answer. It wasn't functional disease, it wasn't nutritional, it wasn't the grass and they just could not find out what was wrong with it. They went so far as to remove the soil. They took out the soil to a depth of a foot, replaced the soil, replanted the area and when it came up, the same thing happened. Ralph finally made an analysis of the soil and found that it was very high in zinc, but there was no apparent reason for this. One day he was thinking about it and he gazed up into the sky and there was the answer: the water had condensed on the guy wire, ran down the insulator and dropped onto the turf. When we see turf in poor condition it is not always easy to determine the cause.

Here is an example of that. You might wonder what was wrong. It might be air movement, tree roots, type of grass,nutrition levels, compaction, over-watering, not enough water. Here are tree roots. That saps moisture and nutrients.

Bob Williams at Beverly CC in Chicago found a green full of tree roots. On another green they found this almost concrete-like mass. It was slag that had been used in the hope of increasing soil porosity.

Here is poor air drainage on another green. There is no movement of air. The attempt is to clear out some of this and get the air moving.

Here is the soil. It is often thought that good black soil is just the thing for greens. You can see the condition of this. It is compacted and it is not good for growth of grass.

Here is another undesirable condition--the sand layer. O. J. showed the sand regime in Milwaukee. It was the custom many years ago to top-dress quite heavily with sand. We know that sand is all right for drainage but we also know that soil directly above that sand layer is extremely wet at all times and that is all the farther the roots will go.

Here is another condition brought about by improper

top-dressing-- a humus layer. This is just like a sponge; it holds that much water. The layer can be broken up by aerifying. You have a choice of two things-- either aerifying or rebuilding.

Here is a green at a course on the west coast. It had been aerified and you can see, where the spoons broke through the sand layer, there you have roots. They went right through the layer and actually hold the turf down. If they do that enough times, they will get rid of that sand layer. This is a close-up of that sample showing the roots. It is just full of roots.

A good indication of compaction is this blue color in the soil. If you see that color you know that oxygen is not getting into the soil.

Here is a green in Chicago that had been aerified in the fall. You can see where the grass started to come up first. It started in every one of those holes.

We find ponding on compacted areas. I want O. J. to tell the story of what Warren Bidwell said about that at Seaview.

O. J. Noer: Warren had a green with ponded water. He told the workman that he should push the water off. The man told him that the water would disappear by the next day. Warren told him that it either disappeared in an hour or he would be off the place. It is that important to get water off the green quickly.

Tom Mascaro: You see this in many areas and the thing is that either too much water was applied or it was applied too rapidly. Here is the effect of walking over an area like that. Even though it looked dry on the surface, we get these footprints. With greens in this waterlogged condition, when high temperatures come, there is trouble. There is so much water in the soil that there is no room for air. Without air, roots cannot function to take up the moisture so the grass wilts. You must get out and syringe the greens to wet the leaves and reduce transpiration even though grass roots are suffocating because of too much water in the soil. Careful aerifying lets air down to the roots and helps dry out the soil.

Here is a matted green. You can take a soil sample from the green and squeeze water out of it. The plants will wilt and about the only thing you can do is syringe it and keep it going until something can be done

to break down this material. Here is that effect again. Here it has been aerified and the roots are starting to go down and decomposition is beginning.

One of the methods to do that is to get in there and comb and scratch and rake and get as much of that material off the surface as you can. Then go in and aerify it. You will find this on many areas. The roots are right at the surface of that green. They won't go down through the soil because there are not enough nutrients and moisture and air down there. Adverse weather conditions can cause it to go out practically overnight.

This shows the effect of breaking through that layer. It is at the Philadelphia Country Club where the layer was rather thin but they broke it up. These plants can stand a lot of traffic and drought.

Here is fairy ring. When you break into these areas, you will find the mycelium growing there. You get these dry spots and you can see it all through. The turf is dying from that.

Here is another example of thatch that had been broken down gradually over a period of years. Many men are setting up programs of aerifying to break up thatch over a period of years. They keep the area in play at all times but gradually overcome the thatched condition. The soil is getting mixed with the thatch layer and eventually the thatch will form good soil organic matter.

Here is thatch onbermudagrass at Sea Island, Georgia. In some places it was five inches deep so that when the Aerifier was run over the area, it didn't even go through to the soil. They had to rake out some of that stuff. Today it is good.

Here is a picture taken in California. You can see right away what is happening. Here all the water and fertilizer that was applied ran off. There is no turf up here where it should be. On that same golf course they had a green they were making larger. They were watering this area and here is the runoff. The green was compacted and hard and growth was stopped because water wasn't going in.

I would like to say a little about athletic fields. This is Philadelphia Municipal Stadium. When the Aerifier was first developed in 1946, this was our first area to work on. We worked with Charlie Hallowell.

The field was mostly crabgrass and Poa annua. We began a program and set it up for about 3 or 4 years. It included aerifying, fertilizing, water management, liming and the right grasses. We began aerifying and were pretty drastic in the beginning. We prepared a seedbed and still used the area. When it was cultivated and dragged, we had these holes. The new seedlings were in here. This shows a series of pictures taken from the start of the program in 1946. This was the field in 1946. All these pictures were taken before the Army-Navy game. Here is 1947 and you can see we were starting to get an improvement. This is 1948 and you can see around the edges it still is not good. This is 1949 and the turf is getting better all the time. This is 1950. Along the benches, where the players stay, there are some worn spots, but in general the appearance of the field has improved very materially-- or else, as Noer says, my photography is getting better all the time.

-o-

SOME FACTS ABOUT FERTILIZERS

J. F. Fudge
State Chemist, A. & M. College System
College Station, Texas

Fertilizers are chemicals applied to the soil for the purpose of raising the level of certain elements necessary for plant growth to levels where optimum crop production can be obtained. The elements most commonly deficient in our soils are nitrogen, phosphorus, and potassium, and it is these elements which are carried by most mixed fertilizers.

Fertilization is only one of a number of desirable practices which should be used in the production of good crops, because nutrient levels are only one of a number of factors which determine yields. For example it would do little good to fertilize to raise nutrient supplies to levels required for a 100 bushel corn crop if the water available for plant growth were only sufficient for a yield of 25 or 50 bushels. High production would do little good if insects and diseases were not controlled by appropriate practices. In many of our soils, the physical limitations on root growth in the soil may be of more importance than chemical limitations on the growth of the entire plant. Consequently, maximum returns from money invested in

fertilizers can only be obtained when the practice of fertilization is intergrated with other desirable crop-production practices.

Different crops vary widely in the quantities of nitrogen, phosphorus and potassium required for high production. Different soils vary widely in their native capacity to supply these nutrient elements to plants, and in their capacity to fix phosphorus and potassium in compounds from which the plants cannot obtain them. As an aid in estimating the quantity of nutrients in a particular soil, a Soil Testing Laboratory has recently been established at College Station for all who desire such a service. The service also includes a fertilizer recommendations based upon the analysis of the soil and the crops to be grown. Detailed information concerning this service can be obtained from County Agricultural Agents or by writing to the Soil Testing Laboratory, College Station, Texas.

Different nutrient elements provided in commercial fertilizers or in the soil perform different functions in the plant. Nitrogen promotes vegetative growth, increases the green color of the leaves, increases plumpness and protein content of grain, increases succulence in leafy crops. An excess of nitrogen in relation to phosphorus and potassium delays maturity, increases lodging, decreases resistance to drought, and causes a sappy growth. Phosphorus encourages root growth and spread, hastens maturity, improves the quality of the crop, is essential to seed production and increases resistance to disease. Potassium improves plant vigor and general health, encourages tuber formation, is essential for formation of chlorophyll, offsets bad effects of excessive amounts of nitrogen and phosphorus, increases carbohydrates, and increases resistance to disease. From these functions performed by the different elements, it is evident that the best fertilizer to use is one which provides the best quantity and balance of the different elements available for crop production.

Plants whose health is suffering from the deficiency of nutrient elements show symptoms of faulty nutrition. When nitrogen is deficient, the leaves are a light green, or the older leaves near the base of the plant become yellow and die. When phosphorus is deficient, the plants grow very slowly and the foliage is dark green, with the older leaves becoming yellow, but more often purplish, and dropping off. When potassium is deficient, the older leaves become mottled or freckled, dead areas appear near the tips and margins, and yellowing begins at the margins and continues toward the

center and in advanced cases, the margins turn brown and curl under and finally the whole leaf drops off.

Nitrogen, phosphorus, and potassium for fertilizer use may each be obtained in several different materials. The most common materials used in Texas are the following:

Nitrogen Materials:

Nitrate of soda, which contains 16% nitrogen
Sulfate of ammonia, which contains 21% nitrogen
Ammonium nitrate, which contains 33% nitrogen
Urea, which contains 44% nitrogen
Anhydrous ammonia (a gas) which contains 82% nitrogen

Phosphorus Materials:

Superphosphates, normal, which contains 16% phosphoric acid (phosphorus pentoxide or 8% to 9% phosphorus (P)
Superphosphates, concentrated, which contains from 30% to 48% available phosphoric acid, or 13% to 21% phosphorus
Rock phosphate, which contains 30% to 33% total phosphoric acid, of which about 3% is available phosphoric acid.
Ammonium phosphates, in which the nitrogen content ranges from 11% to 16% and available phosphoric acid from 20% to 48% (9% to 21% phosphorus)

Potassium Materials:

Muriate of potash, which contains 60% of potash or 50% of Potassium. This is practically the only potassium material sold in Texas. A small amount of a lower grade of this material, containing 50% potash (41% potassium) is being sold.
Sulfate of potash, which contains 48% potash, is a good source but sells at a premium price in the tobacco-producing areas because excessive chlorides lower the smoking qualities of tobacco.

As can be noted from the above data, materials vary widely in their content of the particular nutrient element which they provide. This does not mean that the difference between the percentage of the element present and 100% is "worthless filler" as is sometimes claimed by people who do not know the facts. For example, nitrogen must be in some chemical compound from

which it can be obtained. Nitrate of soda, when chemically pure, contains 28% sodium, 55.8% oxygen, and 16.2% nitrogen. The comparison of 16% nitrogen in the fertilizer grade of nitrate of soda with 16.2% nitrogen in chemically pure sodium nitrate shows that the fertilizer contains no filler at all. In the case of superphosphates, rock phosphate is treated with about an equal weight of sulfuric acid in order to render the phosphorus more available for plant growth. The entire mass is used as normal superphosphate or the phosphoric acid formed in the reaction is removed and used for treating more rock phosphate. This removal is expensive so that the cost per unit of phosphorus is higher, but where the product is used at some distance from the factory, this increase in cost is more than compensated for by reduction in freight charges.

In general, under our conditions in Texas, a unit of nutrient element from any given material is of the same value of a unit from any other material, so that the material to buy is that which is available at the lowest price per unit of the element. This is often different from the price per ton of material, because of the concentration of the element in the material. For example, last year the average selling price of nitrate of soda was $67.00 and the price of sulfate of ammonia was $48.84. The sulfate of ammonia contained about one-fourth more nitrogen than the nitrate of soda, so that the cost of a pound of nitrogen in nitrate of soda was about 21 cents as compared with about 12 cents for nitrogen in sulfate of ammonia. The average price of ammonium nitrate was $77.21 per ton. The amount and kind of nitrogen in a ton of this material were more than would have been carried by a ton of nitrate of soda plus 1600 pounds of sulfate by ammonia, which would have cost $106.07, as compared with $77.21 for ammonium nitrate. By buying fertilizer on the basis of price of plant food rather than price of the complete product, farmers can get their plant food much cheaper.

Mixed fertilizers are made by combining two or more materials carrying the different nutrient elements. In formulating such mixtures, a high degree of knowledge is required, because the mixture makes up a highly complex physico-chemical system, and it is necessary that the mixture be chemically and physically stable. The mixture must be of such a physical state that the materials will not separate but on the other hand, will not combine to make a mixture which cannot be distributed easily, even after a considerable storage period.

Mixed fertilizers are easily described by a numerical designation which indicates the percentages of nitrogen, phosphoric acid and potash in the mixture. For example, the designation 5-10-5 for a fertilizer mixture would mean that the manufacturer claims that 100 pounds of the product contains 5 pounds of nitrogen, 10 pounds of available phosphoric acid, and 5 pounds of water-soluble potash. A designation of 0-14-7, would be used for a mixture which contained no nitrogen, 14% available phosphoric acid and 7% water-soluble potash. A designation of 0-20-0 is the correct designation for the product which is often called 20% superphosphate. This numerical designation for either mixed goods or materials is called the grade of a product. The ratio between the three figures is called the ratio of the fertilizer. Thus, both the 5-10-5 and 12-24-12 grades have a 1-2-1 ratio. In selecting a fertilizer, the ratio should be determined by the relative needs of the crop to be grown and the quantities of the nutrients in the soil, while the grade of that ratio should be the one in which the plant nutrient elements cost the least money.

Obviously, with the large number of very different materials available for making mixed fertilizers, it is possible to make a very large number of grades of fertilizers. Every grade which a manufacturer makes requires special storage space, bags, changes in equipment and many other expenses, which the manufacturer passes on to the farmer. Consequently, the limitation of the number of grades which are approved is definitely in the public interest, so long as a sufficient number of ratios is available to meet the various needs of the farmer. Such limitation of ratios and grades has been in effect in Texas for many years. The kind and number of grades approved for Texas is decided each year by the Texas Fertilizer Committee appointed by the Director of the Texas Agricultural Experiment Station. Other states have similar committees. This Committee has saved the farmers of Texas a very great deal of money through the years and at the same time has seen to it that the selection of grades is such as to meet all their needs.

Very large sums of money are spent each year for fertilizers. Consequently, it is in the public interest to have adequate laws governing the sale of fertilizers to insure that the purchasers of fertilizers are getting what the manufacturers claim. The fertilizer law requires that every container of fertilizer be labelled to show the net weight, the percentages of nitrogen, available phosphoric acid and potash claimed by

the guarantor, and the name and address of the guarantor. The State Chemist of Texas, an employee of the Texas Agricultural Experiment Station, is responsible for the administration of the fertilizer law. Under his direction, about 2,000 samples of fertilizer are collected annually by inspectors and analyzed by chemists employed for this purpose. The law requires that the State Chemist publish annually a statement of the results of this work. The latest annual report is made in Bulletin 738 of the Texas Agricultural Experiment Station, and is available to all interested parties, upon application to the State Chemist or the Editor of the Station. This bulletin presents much statistical work which would be inappropriate in this general discussion of fertilizer materials and mixtures.

-o-

THE SOIL TESTING SERVICE OF A. & M. COLLEGE

M. K. Thornton
Extension Soil Chemist, A & M College System
College Station, Texas

There are a couple of things that have been said this morning that struck me rather forcefully. One of the speakers said something about growing grass on an airfield in San Angelo; another gentleman made some additional comments about it.

In 1940, when the airfield in San Angelo was first established, the officer in charge wired Extension Director Williamson and asked for thorough and explicit details on how to grow grass on the San Angelo Air base. The telegram was given to me and I wired him "water". In many areas in Texas, water is the limiting factor in growing of grass or any other crop.

As Dr. Adams stated, I have been in charge of the soil testing laboratory for the past year and during this--time we have gained considerable experience with these samples. Some samples are taken very poorly. I have one in my office now that was taken from a county up in northeast Texas. We have analyzed over 300 samples from that county. These soils follow a definite pattern. The sample came from an area of acid soils but this sample is definitely alkaline. I took the sample over to Dr. Fudge's technicians for a check because I didn't believe my instruments. They reported exactly what I found. I don't know what happened but I am

sure that the sample is not truly representative. So one of the things I think we must contend with in any soil testing service is sampling.

In submitting a sample from your greens, be sure that it represents the conditions on that particular green. If they don't, the best will be worthless. That means you should sample the green in a sufficient number of places so that you are sure it actually represents that green or fairway.

Also, give us some information about each sample. It is not necessary that you use the printed information sheet. This printed sheet is to aid you in furnishing some of the information we would like to have accompany the sample. A letter is just as good. The reason for this information on the sample is that when we go to make recommendations, we would like to know something of what has been done to the soil.

Don't forget the name and address or who you want us to write to. This seems foolish, but we actually get samples and cannot tell who sent them.

Also give us the address of others who wish reports too. If you wish several people to receive copies of a report, write their names on the information sheet or in your letter.

Ordinarily a sample from a golf course would come from the county in which the course is located. In many cases, we have city dwellers who have farms in other counties that the county of their address. When we report a sample from the county of address, it may be confusing until we learn exactly what county the sample came from. In one case, we had a very salty sample from a man who lived in an area that has no salty soils. We could not understand this until we wrote for further information and learned that the sample was from an area of salty soils.

If you can give us accurate information on these samples, it will be of great help to us in making recommendations.

When you send in samples, don't forget to include a dollar fee for each sample.

-o-

FRED GRAU IN ABSENTIA

Jim Watson
Assistant Professor, A & M College System
College Station, Texas

Fred asks that I express his best to the fellows attending our conference, and to tell you how sorry he is that conditions at home prevent his being with us. He wishes for us a most successful conference.

The U. S. Golf Association Green Section through Fred is continuing their support of our turf research program, both morally and financially. Fred recently sent us a $300.00 Grant-in-Aid. He writes, "it isn't much but it says we're still with you." I would like to mention too that this year through Fred we received an additional $300.00 to carry out our phase of the National Coordinated Crabgrass Control Tests. The American Cyanamid Company made a substantial grant available to the Green Section for use in testing chemicals for crabgrass control. Fred selected Texas A & M as one of the cooperators. There will be a report on this work later in the conference.

Some information Fred passes along that is certainly worthy of consideration is as follows:

(1). AERIFICATION: "Compaction of soils can be corrected with minimum inconvenience to players. Problem exists of learning most efficient use of equipment and "selling" the principle of soil cultivation--to apprehensive officials."

(2). "I'm convinced that aerifying is everyone's most important business when it comes to producing turf. Not everyone will be 100% successful the first time he tries it but each one must learn how best to do it under his special set of conditions.

By aerifying intelligently when grass is growing well and when soil moisture is just right, much less water will be required to produce championship turf. The result will be healthier turf which is more resistant to wear, heat, cold, insects and diseases. Generous fertilization will further reduce the need for irrigation water, all other things being equal."

(3). WATERING: "Proper watering of turf is a subject that is getting a lot of attention in research as well as on the turf. In all too many cases water is applied faster than the soil can absorb it. It is

known that increasing the quantity of water applied per minute actually can result in less water entering the soil. Research on this subject is progressing satisfactorily."

(4). "The Green Section has spent nearly $10,000 on two 3-year studies at Penn State to learn more on this vital subject. Projects have been carried on the same subject (but different phases) at Michigan and in California. As far as watering is concerned, it all adds up to the fact that enough is enough and more doesn't do any good but usually does a lot of harm."

(5). FERTILIZATION OF TURF: "As new grasses are released, each must be studied for fertilizer response. The problem of fertilizer placement seems to be diminishing as aerifying equipment allows material to penetrate into the root zone. We still lack accurate measurements but practical results are apparent and are encouraging.

Research continues on the ureaform fertilizers with commercial production coming a step closer to reality. Results indicate that they perform about like the good organic nitrogen fertilizers and may be expected to supplement the limited supply of organics."

(6). WEED CONTROL: "No need for weeds to exist in turf when existing knowledge of good management, chemicals and equipment is applied. Some exceptions: Dallisgrass and sandspur, in roughs: bent in athletic fields."

(7). PROBLEM OF MISTAKEN IDENTITY: "Positive identification of insects, diseases, weed grasses, etc. brings the scientists of all agricultural fields into play in turf management. Sod webworm damage has been diagnosed erroneously as dollarspot with disastrous results. The control of one type of grub may be quite different from another type. Know your grasses, your weeds, your diseases. The big problem is to bring these questions to the attention of the research and extension on men in each field."

(8). MORE NURSERIES NEEDED: "Nurseries of replacement sod and of new or improved types of grasses can be found at only a small percentage of golf clubs. There is a real need for more intensive local study of new developments. Regardless of how enthusiastic we become about improved turf grasses which someday will make the superintendent's work easier we are continually reminded that there is a lot of day-to-day maintenance on just ordinary grasses which needs doing. We must continue to try to improve what we have, dis-

couraging though it may be at times. But, while this is going on there is no good reason why nearly every superintendent should not have a nursery of every improved grass which becomes available. Only in this way can one gain knowledge of performance under local conditions. Each nursery in effect becomes another experiment station, particularly if it is associated closely with the research and extension personnel of the State Agricultural College or of the Green Section."

(9). ABOUT SOME OF THE "NEW" GRASSES: "Domestic production of Zoysia seed has become a real possibility in the last three years. High seed-producing strains of Zoysia have been tested and proven. This news should be of great interest to cemeteries and parks over a large part of the United States because Zoysia seems to be a "natural" for cemetery and park turf. It is disease, insect, heat, cold, drought, and wear resistant, and it requires the minimum of attention. It grows on subsoil nearly as well as on topsoil. The story of Zoysia will be well worth reading. It will appear soon in the USGA Journal."

"Polycross creeping bent seed should be given exhaustive test under play in all sections of the state. Polycross seed has the possibility of replacing all other bents now being used for putting greens."

(10). ABOUT THE GREEN SECTION: "Cooperative research with state experiment stations has developed beyond our fondest dreams. The program is on a sound level foundation now under a plan of friendly coordination which is producing excellent results efficiently. Three major achievements can be cited as the direct result of the Green Section cooperative decentralized program:

1. Many scientists are participating. Seven years ago about 10 people were active in Turf work in the United States. Today the number is close to 100.

2. A growing pool of vital research data is accumulating for use by extension people to give to the practical user. The Green Section's Turf Research Review lists all known projects.

3. A group of keen young men has been trained in Turf Management. They are accepting positions of trust and responsibility in research, teaching, extension and industry. These men had to be trained first before there could be developed an effective plan of

SERVICE."

"Green Section Service Subscriptions have grown steadily without fanfare or high-pressure propaganda. Nearly 200 firms dealing in Service to Turf belong to the Green Section's official family at $35.00 a year. Twenty-four dollars and fifty cents of each subscription goes into the Green Section education fund to support cooperative research and extension activities. Ten dollars and fifty cents goes to the USGA general fund to help cover Green Section costs incurred in servicing the subscribers. Many seedsmen have discovered that a Green Section service subscription helps them to keep ahead of their customers in the "new" things. Several Golf course superintendents associations have given a helping hand. USGA member clubs are beginning to realize that a Green Section Service subscription, in addition to their $35 membership dues, doesn't hurt but really helps. Piping Rock on Long Island was the first USGA club to take a subscription."

"Turf Research Fellowships and Research Grants are established as the need is felt and as approved projects are presented. The problem today is to find qualified men to take the several fellowhips that are vacant. The Green Section will entertain requests of grants-in-aid to develop better service to member clubs and to subscribers. If research must wait for more settled world conditions we can develop more fully the information at hand to present in useable form for the practical man who is faced with every-day problems of turf maintenance."

"The Turf Advisory Committees have been major factors, in providing a strong link between the college and the field. Success in every state or regional turf program very nearly can be measured on the basis of the strength of the advisory committee. The committee, properly constituted and recognized officially by the college administration, has power far beyond its original purpose of helping to designate needed research projects. It can lend valuable support to the research staff by making requests for money and equipment to the responsible parties and, when needed, it can become a powerful friend of the college in official circles. Any research staff that operates without a strong officially-designated Turf Advisory Committee lacks an essential part of the working mechanism. Cooperative projects in which the Green Section participates financially are easier to plan and to execute with the backing and the counsel of the Committee -- and the project usually is developed on a sounder basis. Some of the more active committees operate in

connection with Penn State, Tifton, Purdue, Oklahoma, and California."

(11). AVAILABILITY OF INFORMATION: "We still have a few copies of Turf Research Review left - $1.25 a copy. We will appreciate it if you will take the orders and forward them to us with the money. We'll mail them right out.

Is Musser's book, TURF MANAGEMENT, hardly at the bookstore? Every turf superintendent and chairman should have a copy in his library? "All good luck to you, Jim, and give my regards to everyone."

-o-

PROBLEMS OF AIRFIELD TURF

J. I. McGregor
Flying Training Air Force, Waco, Texas

I am no authority on airfield turf. In the flying training air force we have some 25 activated bases and 16 more in process with all the information coming out in the papers about increasing the air force and each one presenting new problems.

The gentleman who spoke this morning said that the air force would have to recognize certain principals, that it would take a long time to accomplish certain result. If we went by that factor, we would still be back in the reciprocating engine--not in the jet class.

We have to fly these planes and train these boys and I don't know if there is a man in here who is qualified to say whether we are further from an all-out war than when Duke Thornton was talking about answering that telegram in 1940 about World War II. We can't make our potential enemies fight these wars when we want to fight them. We must fight them when they do for we are not an aggressive nation. So that brings our problem to the fact that we have to face conditions as they are and do the best we can with it.

In the discussion this afternoon I am just going to touch briefly on the problems of heavy air craft that land on paved runways. Our turf problems on air force grounds where we use paved runways is entirely different from the problems of turf where we use light training air craft under 10,000 pounds that land on turf.

Boys on their first or second solos don't land on the same rut each time. When you are driving down country roads, you keep in the same rut. The result is that there will be a strip four,five or six feet wide where each wheel hits. Soon that will become just as bare as it can be. We have to shift the landing strips every two or three days. Even if you have a 1200 acre field, you can't locate it where you can keep grass on it. This picture was made in 1950 and if you look at it closely you will find that there is no turf anywhere within the landing areas except for a few spots. In 1950 there was turf on those spots. (Aerial-photograph of an active air force base, denuded of turf.)

Duke said that he sent the telegram saying just one word--water. He might not have realized just how much information he did give. If you look at that picture again,you will see a complete underground system. That 1200 acres can be irrigated by the addition and use of 8000 feet of portable, four and eight inch pipe. In this particular area we ran out of water last July and there has been none since. What are you going to do about water when you can't get it? We found that the city sewerage disposal plant has an excess of three to five million gallons of water suitable for irrigation daily, and we are at present trying thru an 8 inch-7000 foot line to hook up with the present irrigation system so that we will have that water even in drought time. Most of our air bases has a sewerage disposal plant. That is one of our problems and we have accumulated since the war literally thousands of cubic yards of sludge. We are right now in the process of using sludge grinders and manure spreaders to distribute that sludge over the flying fields.

An air base ground is composed of three parts--improved ground, which is around the barracks and residential area and headquarters and which we keep mowed about an inch and a half. Bermudagrass as a rule is used. The second part is the air field grounds which are adjacent to and around the runways and taxi strips; any place that could be ordinarily used for emergency landing for an aircraft that is in trouble. The third part is the other base grounds. Our problem is keeping coverage on landing areas and the title of this little discussion is airfield turf.

Those of you who have heard some of the questions I have been asking since the conference started will know that I am here seeking answers because we don't know them. We have found certain things we would like to see developed for it would help us in our work. We would like to see Tom Mascaro's Aerifier that works on golf

greens and fairways and on limited parts of the landing field developed so that we could run over 1200 acres in about 24 hours every three or four weeks. We would like to see it go a little farther. We would like to see it reach down and take out a soil sample and then be so geared up that down at the bottom of that hole it would leave the fertilizer so that we wouldn't have to put the fertilizer on top. I am telling you that it won't be long before some boy will figure out how it can be done. We are talking about mechanical aeration this morning and the use of chisels. These airfields get packed 24 to 30 inches in depth. I think Tom will bear me out that they can get packed even worse that that, especially if they are built within eighteen inches of the top soil. So our problem is to get down and break it up and leave a channel where the water is to go.

Most airports are fairly well located near stock yards where we can get manure. There you can take it out and spread it on airport grounds. It adds organic matter and if you have the channel open, a certain amount of it goes in. It has a moisture holding capacity and is a channel for roots and water storage. Of course, it may close up again but we are up against this proposition. We can't wait two or three years to restore turf. We can't tie an airfield up. We don't know how long our potential enemy will put this thing off and we have to be ready when they hit, so we can't tie up any facility we have. We have to use our human ingenuity and our readiness to tackle any problem to solve these problems as they exist.

On some bases we have had to put on a dust pallative over the entire field. We must control dust in Arizona and Nevada. On a field where we have 40% dust control, the average life between engine changes is 314 hours. Where you have 75% dust control, the average life between changes is 476 hours. Where you have 90% dust control the average life between changes is 526 hours. So you see there is a direct ratio between dust control on a flying field and the number of hours a motor will fly. Why do we worry if we have to change after 314 hours? In the plane that goes up, the engine may stop because of a little dust in its mechanism and it might be your son flying. There is a hazard involved that no right-thinking American is going to try and dodge. We are going to try to meet it and solve it.

We have three or four golf courses on three or four bases in the country. Not too long ago the papers were full of criticisms of the air force for putting in golf courses. It was just like the criticism A & M

College received for putting in a golf course here. Let me give you just one thought. Take an air base where you have an average of 2500 men. If you have adequate facilities (and this is borne out by statistics) your court marshal records are within reasonable limits. Where you don't have it, your court marshal go to high limits. The boys go away from the base because there is nothing on the base to take up their surplus time between working hours. Our football field would take 22 men two hours. Our baseball diamond would take some 25 or 30 men two or three hours. You know how many men a golf course can keep occupied in any given day and the investment in the moral welfare of those young men is amply justified. I trust you gentlemen will bear in mind that the golf course wasn't just some way we could think of to spend money--it is an investment, in the moral fiber of the finest boys in this country that are having to be trained to fly in order that we might survive as a nation.

We have a requirement that grass cannot grow over 15 inches high on a flying field area. Then it has to be mowed down to 8 inches. We have these sickle type mowers. We have any number of mowers that work on the improved grounds and lawns. But on an air force flying field, we need a mower that will cut that 15-inch grass and chew it up-- not lay it down with 10 or 12 inches of dry grass in one mat. In the first place, it creates a fire hazard and we have to keep fire trucks right out on every field where there is flying continually where we have grass. A grass fire is one of the worst things that can happen on a flying field. The second thing is when the grass is chewed up and allowed to work back in to the eight inches, it immediately becomes organic matter. It will decompose and go right back in the soil to add to the organic content.

When we first build an air base, we put on ample applications of phosphate. After that we use very little on the flying field, because in our mowing it all goes back to the ground and we don't take it off. The phosphate is not removed. It has been pointed out time and time again that nitrogen is moved around. It goes off in the clippings and it is lost and we have to replace it. Generally we use 40 pounds of inorganic nitrogen per acre in our arid and semi-arid base areas. We use 80 to 100 pounds in our humid regions. We apply that in about three applications one before the grass starts growing in the spring. We put that amount on again April 15 to the 30 and again June 1st to July 1st depending on moisture conditions and whether it is an irrigated base. We do that to furnish a protective, cover to keep down dust.

The picture shows this base to be bare, but right out on the base itself, there are clumps of grass roots. The tops are all gone but there is a little huddle sticking up about three or four inches high where those roots were in the soil. Imagine these student fliers trying to land a plane on the area on these little clumps. It is just like you taking a car and trying to drive down a street and discover alot of bricks scattered all around. You know what a time you have controlling your car. A light plane is a lot harder to control than a car.

I would like to ask your coeperation in visiting the air installation officer and offering your help toward solving our problems. If you think you have a solution or if you think you have a contribution towards solving the turfing problem on that base, please tell the air installations officer.

I happen to be one man serving these bases, so you can see how much time can be devoted to each base. We try to set up a general over-all program. We invited in the soil conservation boys, we invited in the county agents and this is the first opportunity to invite you gentlemen. We are in the defense effort right out there on that air base, trying to build our country up so that we can continue to exist. We need your active cooperation to help so that we can do it.

-o-

LAWS REGULATING THE SALE AND USE OF HORMONE HERBICIDES IN TEXAS

Don Dudley

Herbicide Regulation No. II

Regulating the sale and use of Hormone-type Herbicides. This regulation repeals and replaces Regulation No. I.

Effective January 28, 1952

WHEREAS, the Commissioner of Agriculture of the State of Texas has been directed by House Bill No. 593, Acts 52nd Legislature, 1951, P. 681, Ch. 394 (Article 135-b-3), to promulgate regulations governing the sale and use of hormone-type herbicides, and

WHEREAS, it has been found that the provisions of Regulation No. 1 under House Bill No. 593 are inadequate

to effectively control herbicides in order to minimize damages resulting from spraying and such regulation is inequitable in its effect upon various agricultural industries.

NOW THEREFORE, I, John C. White, Commissioner of Agriculture of the State of Texas by virtue of the authority vested in me by House Bill No. 593 Acts. 52nd Legislature R. S., P. 681 Ch. 394, 1951, do hereby repeal Regulation No. 1 promulgated under said House Bill No. 593, and in lieu thereof I herein promulgate the following:

I. As set forth by law, the purpose of these regulations is to regulate the sale and application of all hormone-type herbicides in all counties within the jurisdiction of House Bill No. 593.

II. Only in the following counties is the Texas Herbicide Law and these regulations effective and in force; Anderson, Angelina, Aransas, Atascosa, Austin, Bastrop Bee, Bell, Bexar, Blacno, Bosque, Bowie, Brazoria, Brazos, Brown, Burleson, Caldwell, Calhoun, Camp,Cass, Chambers, Cherokee, Colling, Colorado, Comal, Comanche Cooke, Coryell, Culberson, Dallas, Delta, Denton, DeWitt, Ector, Ellis, El Paso, Erath, Falls, Fannin, Fayette, Fort Bend, Franklin, Freestone, Galveston, Goliad, Gonzales, Grayson, Gregg, Grimes, Guadalupe, Hamilton, Hardin, Harris, Harrison, Hays, Henderson, Hill, Hood, Hopkins, H uston, Hudspeth, Hunt, Jack, Jackson, Jasper, Jefferson, Johnson, Karnes, Kaufman, Kendall, Lamar, Lavaca, Lee, Leon, Liberty, Limestone, Live Oak, Loving, McLennan, Madison, Marion, Matagorda Maverick, Medina, Midland, Milam, Montague, Montgomery Morris, Nacogdoches, Navarro, Newton, Orange, Palo, Pinto, Panola, Parker, Pol, Rains, Red River, Reeves, Refugio, Robertson, Rockwall, Rusk, Sabine, San Augustine, San Jacinto, San Patricio, Shelby, Smith,Sommerville, Tarrant, Titus, Travis, Trinity, Tyler, Upshur Van Zandt, Victoria, Walker, Waller, Ward, Washington, Wharton, Williamson, Wilson, Winkler, Wise, Wood.

III. Definitions as used in the Texas Herbicide Law and these Regulations.

A. The term "herbicide" means all harmone-type herbicides which is any substance producing a physiological change in plant tissue, without burning, including 2,4-D and any derivatives, which are used for the purpose of preventing, destroying, repelling or mitigating any weed.

B. The term "weed" means any plant growing where not wanted.

C. The term "person" means any individual, firm, partnership, association, corporation company, joint stock association, or body politic, or any organized group of persons whether incorporated or not; and includes any trustee, receiver, assingnee, or other similar representative thereof.

D. The term "dealer" means any person who sells offers or exposes for sale, exchanges, or gives away any hormone-type herbicide.

E. The term"applier" means any person applying hormone-type herbicides to any land in this State by aircraft, ground or hand spraying equipment.

F. The term "aircraft equipment" means any machine or device designed for or adaptable to use in any contrivance used or designed for navigation of, or flight in, the air for the purpose of applying hormone-type herbicides as sprays, dusts, aerosols, fogs or other forms. Hand spray equipment is specifically included herein.

IV. General Rules

A. The application of hormone-type herbicides in dust form is prohibited.

B. Hormone-type herbicides shall not be stored, or transported with seed, fertilizer, insecticides or fungicides because of the danger of contamination.

C. Any person who engages or employs a person to apply herbicides, who is not licensed, bonded is violating the Herbicide Law and these regulations.

D. All Checks must be made payable to John C. White, Commissioner of Agriculture.

V. Dealers

A. Sales by retailers, distributors, wholesalers, and manufacturers of herbicides are sales within the terms of the Herbicides of Law and require a license for such sale.

B. Any dealer selling herbicides in any of the counties covered by the Herbicides Law must have a Dealer's License regardless of whether or not such seller is located in such counties.

C. Any seperate entity shall be regarded as a distinct and independent dealer for purposes of requiring a Dealer's license and keeping records.

D. All dealers are required to make and retain the following records and to submit a copy of such records each month to the Commissioner of Agriculture. A copy of all records must also be retained by the dealer for a period of two (2) years.

1. Name of the purchaser.
2. Mailing address of the purchaser.
3. Date of sale or delivery.
4. Amount and kind of herbicide transferred

In addition to the above information a retailer must obtain and retain the following records:

1. The area to which the herbicide is to be applied.
2. The signature of the purchaser or agent.

E. Fees

1. A dealer selling herbicides in containers of more than eight ounces must pay a license fee of fifty dollars ($50.00).
2. A dealer selling herbicides in containers of eight ounces or less must pay alicense fee of five dollars ($5.00).

VI. Appliers of Hormone-type herbicides and the land or crop owner.

A. General - applicable to both appliers for hire and persons applying to own land or crop.

1. Hormone-type herbicides shall not be transported over or across country for adistance greater than five (5) miles, in bulk or in any type of distributing equipment ready for application to land provided, however, the Commissioner of Agriculture may extend such distance by special permits for spe-

cial permits for special containers r mixing tanks.

7. Spraying equipment shall not be moved for a greater distance than five (5) miles from the place of appli until such equipment has been flushed out with clean water.

3. Permits and fees:

(a) Either the person applying or the the land or crop owner must have paid the fee of ten cents (10¢), per acre if more than twenty (20) acres are to be sprayed, before such spraying is done.

(b) If less than five (5) acres are sprayed in one year, no permit or fee is required.

(c) If more than five (5) acres but less than twenty (20) acres are sprayed in one year a permit, (notice) to the Commissioner is required but no fee need be paid.

4. Records

Both the person applying the herbicides and the land or crop owner must keep the following records of each application for a period of two (2) years.

(a) The name and address of the person or persons in control of the land or crops at the time of application.

(b) The name and address of the person and firm making the application of herbicides.

(c) Exact location of land including county, city, community, and directions.

(d) Date and time of day the appli- was made.

(e) Velocity and direction of the wind at the time the application was made.

(f) Quantity and concentration of the hormone-type herbicides applied per acre.

(g) Total acreage treated.

(h) Type of crop treated.

5. Equipment license tags issued by this office shall be kept with the equipment at all times.

B. Persons applying hormone-type herbicides for hire are required to:

1. Have their equipment insepected and licensed and to pay an inspection, fee of Ten Dollars ($10.00) for each piece of equipment. Equipment will not be licensed until it has been inspected and the required bonds are on file in the Department of Agriculture.

2. Furnish a surety bond of Five Thousand Dollars ($5,000.00)

3. Furnish an equipment bond of One Thousand Dollars ($1,000.00) for each piece of equipment used.

4. Both the surety and equipment bond must be signed by a surety bonding company authorized to do business in Texas.

5. Have a spraying permit, if the land or crop owner does not have such permit, before the spraying is done. A Blanket Permit will be issued as a spraying permit provided a Suppementa1 Spraying Permit for each spraying operation is submitted to this office on forms furnished by this office.

. Have equipment inspected and licensed each year.

C. A person using a plane to apply herbicides to their own land must meet the same requirements as a person applying for hire except a surety bond and equipment and equipment bond are not required. All aircraft equipment must be inspected and licensed.

VII. Equipment Requirements

A. Equipment must be equipped with a screen of not less than 75 mesh, easily accessible for cleaning, unless the spray is properly screened before being pumped into the distributing equipment.

B. Hose connections shall be made of material, and so constructed as to eliminate any possible leakage.

C. A positive cut-off valve shall be installed between the tank and outlet and each outlet shall have a positive cut off valve.

VIII. Spray Operations

A. Farm Crops

1. A wind gauge shall be at the place of application at all times during such application.

2. Spraying shall only be done under the following conditions:

Wind Velocity	Distance from Susceptible Crops	
	Downwind	Upwind
0-3 M.P.H.	1 Mile	½ Mile
4-6 M.P.H.	2 Mile	1/8 Mile
7-10 M.P.H.	4 Mile	250 Feet

3. Spray shall not be released from a height greater than ten (10) feet above the crop. Spraying must be done at the lowest height, that is safe and practical under the existing conditions.

4. Loading depots will be situated as far from susceptible crops as possible.

B. Brush

All regulations applicable to farm crops in VIII. A. Above shall apply to brush operations except that the spray shall

not be released at a height greater than fifteen (15) feet above the top of such brush.

Promulgated in the City of Austin, on this, the 28th day of January, 1952.

-c-

THE QUESTION BOX

Bob Shelton, Chariman

Marshall Stites: areas of bare spots. These areas are all sloped. What is the best method to get bermuda on these areas?

J.R. Watson: There's one thing you can do that I believe may help. Apparently the problem is being able to get into the soil. The first thing I would say to do is to aerate it with any type of aerating equipment you can get. Apply some fertilizer. I assume you have no irrigation water available. Therefore, you should aerify, fertilize and seed if there is not enough bermuda present. Do this when you have had rain.

DeWerth: I don't know too much about grass but if these areas aren't too big, I think your main problem is washing. If you would cut a strip of bermuda and strip it across in the opposite direction that you have washing and put these strips six or eight inches or a foot apart and then over-seed, you would probably get grass established.

Shelton: I might add if he wants to get something to grow on it this winter, why not seed some ryegrass? If it is practical, you can always mark these areas. Ryegrass will help to hold the bermuda seed in place next spring.

Question: What kind of disease is dollarspot?

O. J. Noer: Dollarspot is a disease caused by fungi. It appears as a small spot and is anywhere from a dime up to a dollar as it is called. Anyone of the better fungicides--Cadminate, PMAS, Calo-chlor--are the best materials to use for it's control. We like to see

preventive measures taken before the disease has a chance to kill the grass.

Question: Will fertilization prevent brownpatch?

Watson: Fertilizer, as such, is not a fungicide. It will not control disease. If your grass is susceptible brownpatch will develop when climate conditions, favoring the disease organism occur, however, the chances are that the grass will recover more quickly, and infestation will not be as severe if the turf has been fertilized properly and is vigorous and healthy.

O. J. Noer: As far as brownpatch is concerned, I think that in areas where bent is grown, regular treatments for the prevention of dollarspot should be used. The same applies for brownpatch but the hold-over effects are not as good with brownpatch. Therefore, it is a matter of getting in and stopping the disease the minute it appears. That may mean spraying several times a week. These clubs in the belt from Kansas City to Washington where brownpatch is the principal disease during the summer prefer a material like Tersan. Because it does not injure the turf as badly as a corrosive sublimate which is sometimes used. They also supplement with Calo-chlor when the grass is in bad shape. Tersan is a material which is much safer to use and it does kill the disease. Some people use a little corrosive in with the Tersan and think that the addition of small amounts of possibly an ounce or ½ an ounce of sublimate to a green helps to improve the quality of the Tersan insofar as stopping the fungus is concerned.

Question: What is the most effective way of eradicating dallisgrass?

Watson: We don't have a chemical that is selective for Dallisgrass. The most effective method is to dig it up, but this will run into a labor problem. I have seen used at Fort Sam Houston and on the Lakewood course in Dallas. It will burn a spot out and destroy bermuda or any other grass that is in that area. Then if you will go in and fertilize, the bermuda will grow back in the areas. At Fort Sam they had coverage over those spots in four weeks. Mr. Bowman of the Lakewood Country Club has used gasoline in the fall and by mid-summer, he reports that he had an effective cover of bermuda. Mr. Dubose of the Houston Country Club, Houston, Texas, said he has used diesel oil very effectively and killed dallisgrass on his fairways. He plans to go all out for it next year. He reports that in 60 or 90 days the bermuda has covered and filled

over the treated areas. He used just a small spray nozzle and applied it directly to the crown. Dr. O. J. Noer reports that the Los Angeles Country Club used the same thing very effectively.

Question: Can Vermiculite be used in a green to increase porosity?

J. B. Page: I would think it could be although I have had no experience with the material being used in his manner. Vermiculite, it, certainly would be more favorable than some materials you might add because it does have a lot of internal porosity, until it is compacted.

Noer: There was some used down at Camergo in Cinncinnati. Taylor Boyd used it there the first season but felt he had used too much. The surfaces tend to stay put. Later it began to get compacted and he feels that it is partly a matter of quantity. You can overdo it.

Question: When can potash be put on bent greens and how much should be used?

Noer: Potash has become more and more important in our bent seedings in the north since we have stopped top dressing as much as we did in the old days. I am not saying it is better to top doress. In many instances in our bigger courses, cost has been the big factor and the proper character of top dressing was not used. As a result, many greens are not top dressed. In the old days when manure compost was being used as a component of the top dressing mixture, we were actually using more potash than we realized. While the percentage in content of potash in manure is low, the volume applied was quite a bit. In a six month growing period in Milwaukee, we weigh and analyzed the clippings and found that we took off four pounds of potash per thousand square foot. During a normal growing season, you will have to multiply that at least tiwice. That figure seems to be correct and if you use that much, you won't go wrong. I am talking about actual potash now.

Question: How thick should you spread barnyard manure mixed sand on greens and fairways?

Noer: I suppose down here you use some manure we don't use much in the north. Twenty-five years ago when I started in the business, many Scotsmen thought that without manure, they wouldn't be able to maintain a golf course. I think the trend now is to use other

materials. Probably even from a cost standpoint fertilizer is cheaper to put on then manure and if I put manure on, I can't see any point in mixing sand with it. However, if you put on tons of manure, I think your golfers will tell you what to do.

Watson: I agree with Dr. Noer on that. However, if you are going to use it, I don't think you would want to put it on any thicker than your top dressing. To my way of thinking, that would not exceed a quarter of an inch at one time.

Noer: When I first came down to this area, it was customary to use diary loam. However, since they are using a good soil--compost, sand and a peat mixture--rather than one containing a lot of combustionable materials, they are getting much better results.

Remark: Manure isn't really a good source of organic matter. It contains probably 60% water. The other material decomposes rapidly in the soil so that the effects we want to get from manure, we can get from some other material.

Question: How about using manure?

Watson: Manure falls into the category known as dynamic organic matter. Static is the other category, peat is an example. In Texas we don't have good peat bogs. We can get raw sedge peat out of the north or very often we will use baled peat. We do have one or two so-called bogs in the state. However, I doubt if we could classify them as peat--they probably would be considered a high grade muck. The thing to remember about manure is that it decomposes very rapidly.

Question: What is maleic hydracide and what is it used for?

Thornton: It is being used to quite an extent in many areas to control plant growth. If you are trying to retard the grass, it is very practical. But if you are trying to stimulate the growth of grass, don't use it. The whole think hinges on what you are going to use it for.

Question: Would it be practical to try it on shade trees to bring the tree up to its normal size and slow its growth down and hold it there?

Thornton: I don't know. We haven't used hydracide for more than three years so I really couldn't say.

Remark: I tried crabgrass. I was very much impressed with it. It slowed the grass down. After the third application we didn't have any more growth because we didn't have any grass left.

Watson: Hydracide was used in Ohio in an effort to control grass on the highway banks and they were not too enthusiastic about it. I think the USGA Green Section put out a notice a year or so ago to the effect it may control the growth of grass, however, if used large quantities, it would kill the grass and if used in small quantities, it wouldn't do any good.

Question: Discuss some pre-emergent weed control for chemicals treating soil to kill weeds before you plant the seed.

Zimmerman: We have been using calcium cyanamid for this purpose. Quite a bit of work on this has been done at the Rhode Island Experiment Station under Dr. DeFrance. He used this material at rates from 15, 20, 25 and 50 pounds per thousand square feet at six days, two weeks and four week intervals. He found that this method of using calcium cyanamid is very practical. It controls most of the common weed seeds found in turf beds in that area. However, there is a waiting period, depending upon the availability of moisture, before you can seed.

Mascaro: The picture I showed last night of the Merion blue grass fairway was used with cyanamid on it. I think they used fifty pounds per thousand and then seeded.

Question: Have you had any experience with Methyl bromide?

Shelton: We used it on rose beds. We were interested in getting rid of a lot of things such as nutgrass and nematodes. We don't know if nematodes were present or not. I don't think they were. The nutgrass was stunned for a while but grass came back in. However, it stopped the growth long enough to get the roses in and I'd say that the nutgrass was less in the treated beds than in the ones untreated. I think it was pretty successful.

Question: Exactly what is polycross bentgrass?

Dr. Holt: I think we could classify polycross bentgrass as having come from seed which was taken from a number of plants. The plants had been isolated with 8, 10, 12 or 15 others, so that the only pollen source

you need was from these plants. You get random pollination among these plants and the seed then collects and composites. That would be called polycross seed.

Noer: I would like to refer to the polycross plots of Burt Musser at Pennsylvania State College. I saw them twice this year. The polycross bent he has there looks to me about as good as any I have seen. It certainly was outstanding on the test plots. There is about 400 pounds of seed available and only costs $7.50 a pound.

Question: Which strain of bermudagrass have found that has as fine a blade as bentgrass that might be used in the Dallas area?

Watson: None, however, we hope to have a bermuda like that one of these days. There is T-35-A which we mentioned yesterday and it shows some promise.

Question: Is there any difference in the care of bermuda grass and St. Augustine grass?

Watson: Bermuda grass has a much higher fertility requirement than does St. Augustine. St. Augustine requires more water than bermuda. There are other differences but those would be the two major ones. St. Augustine grass is very shallow rooted and that is one reason why it requires the water it does. St. Augustine will also grow in the shade but bermuda won't.

Question: What is the effect of aerification on turf?

Noer: The aerification of bermuda would help the turf lot but I don't know about St. Augustine. I will have to pass that for I have had no experience with it.

Tom Mascaro: Florida is the only place I know of. I think O. J. Noer has seen some of the areas.

Noer: Most of the St. Augustine in Florida is on lawns It is not used on golf courses. I only know of one course that has St. Augustine. The others have been killing it with sodium arsenite. I understand sodium arsenite didn't do such a good job here in Texas. St. Augustine is one of those grasses that grows very dense in some areas. Perhaps if it is being used at all on fairways or turf areas, thinning it out would increase the vigor of the grass.

Comment: We use it a lot in cemeteries and we are trying as rapidly as possible to completely cover the cemetery. We have one problem in particular. Where

there is little or no traffic over the grave areas, St. Augustine is getting so deep that I doub' if the grass roots are getting down into the soil at all.

Question: Is there equipment available to irrigate shrubs and trees deeply?

DeWerth: Yes, there is pretty good equipment if the area is not too large or if you have the necessary labor. We find that in a year, especially like this year, one of the Root irrigators made especially for this purpose does a very good job down to about three feet. The big difficulty with this is that you must have some course of water and the necessary hose to cover the area. I think if it is lawn areas you are interested in covering, probably the portable system should be used. Sprinklers would probably be the best thing you could use because they put on a considerable amount of water and will saturate if you let them on long enough. This irrigator is a very simple device. It's merely a long tube-like affair with three holes and a very sharp point on it. You can push this into the ground no matter how hard it is by allowing the water to trickle in until you get it down. This summer in the dry areas you could see the soil raise up in a six foot radius after you put the water in. It works very well. There are similar things that are supposed to feed and so forth but don't work very well. That's a very simple apparatus and in areas where you can get at it with the hose, it works perfectly.

Question: What is the lowest temperature at which you could expect to get germination of ryegrass seed?

Watson: You can expect good germination of ryegrass seed some where about 35 to 45 degrees. You won't get much growth out of your ryegrass where the temperature is lower than 35 or 45 degrees.

Question: Explain the hozon attachment for feeding liquid nitrogen or potash.

DeWerth: That attachment is a very simple device. You fasten this device on the hydrant with a very small nozzle-like device and thenput the hose on. On one side there is a little orifice with a little rubber hose which will siphon the concentrated fertilizer solution out of the bucket. It is calibrated under ordinary water pressure from 20 to 60 pounds to feed it at the rate of an ounce in 2 gallons of water which is the recommended rate for either muriate of potash or any of your straight potash materials that are soluble and ammonia sulfate or nitrate of soda. If you use

ammonia nitrate, then you have to put less of that material in your stock solution. It is calibrated to feed at that rate so that by the time you empty a 3 gallon bucket, you will have fed about 50 gallons out through the hose.

Question: There might be away to use this for soil treatment but it would take a better engineer than I am to figure out just how to use it.

Comment: I have used DDT & Chlordane emulsion in this way, whether I put on enough or not I don't know.

Question: I have a seedbed that is thick and green in the Aerifier holes but thin in other places. Should I top dress lightly and seed again or how long will it take for the grass to run together?

Watson: I don't know just what I would recommend. Chances are if it is fertilized properly, that the bent will cover rapidly. If the stand is extremely sparse and if you only went over that green about one time, and in other words if your Aerifier holes are six to eight inches apart, chances are you would want to go in and seed again. I would say it depends entirely on how rapidly you want a cover on that particular green.

Question: Is that a bermuda green in which bent is being used for winter play?

Answer: Yes, but most of the bermuda is dormant now. I kept the old bent all through the summer. It gets thin in spots. When I sowed, I cut it real short and I aerified them twice and some of them three times. It looked just like a checker board. The grass only grew in the Aerifier holes.

Noer: I saw a lot of that in Mobile, Alabama, and New Orleans and even in Houston on greens and fairways. Most of the ones I saw were seeded with rye or red top to provide temporary cover for play during the winter time. The bent will gradually spread and close in those areas, but bent is slow to spread. Rye or red top will spread much faster after immediate sowing. Both will germinate about the same time. I thought at one time the boys in Florida would be smart and use bent for their winter greens instead of rye, bluegrass or red top. Then I changed my mind because it will germinate just as fast. However, there is a lag anywhere from 3 to 4 weeks before it really starts to spread and starts to give coverage. If your coverage

isn't satisfactory, a little additional seeding might be advantageous. But I believe that the grass will spread and ocver. I think you probably weren't rough enough in using the Aerifier and spiker. Instead of once or twice maybe you should have gone over that area five, six or seven times to get a good seedbed. Then seed it and you would probably have had a better and more uniform stand than you have now.

Tom Mascaro: We had a meeting a couple of days ago in the Philadelphia area, they reported no less than 6 times over a fairway when renovating. Some of them went as high as 8 and 12 times to get enough holes. It holds true even on greens.

Gregory: I have come to the conclusion from what I have seen that the use of an Aerifier prior to seeding shouldn't be recommended. If you use it once or twice across the green, your holes are spread too far apart. What I would suggest and what I think might work a little better would be to use a spike or something similar to punch enough small holes to catch your seed. First remove your existing turf so that you can plant your seed close to the top. Then use a spike 3, 4, 5, or 6 times across the green so that your seed will come up much closer together. After your grass is established, if it is a creeping grass, you can aerify it.

Noer: The best greens that I have seen anywhere for winter play are at Pinehurst, North Carolina. They have the advantage that the course is not played during the summer time. All they do during the summer time is fertilize and water the bermuda so as to get a base to seed their winter greens. The greens are mowed with fairway units because they are not in play. Then in September they are aerified 5, 6, 7 or 8 times. You'll never get a uniform coverage from seed unless that seed makes contact with the soil. Those of you who try and seed on top of a mat of bermuda are going to wonder why the only place you get winter grass is in the Aerifier holes. That's because it is where the seed makes contact with the soil. If you want good coverage, see that you are rough enough with that bermuda at the time you seed so that the seed makes contact with the soil and you'll get coverage.

Comment: If you have good bermudagrass, you won't have to do what you are talking about. I'm not criticizing what you siad. You wouldn't even have good bermuda greens if they didn't keep in contact with the soil. Keep them down to about 3/16" during the summer. You have to keep them down there and the soil has to

be almost in sight all the time.

Noer: The soil shouldn't be in sight but you should have enough top dressing on there to keep the runners covered, and then you should have enough nitrogen to keep that grass growing so that sufficient leaves are present. The best stand of grass that I saw once was down at Sonny's place when he was starting off on his own. There was one green where the stand of rye-grass was much better than on any other. I asked him what he had one on that green that he hadn't done on the others and he told me he had put on a good dose of Milarsenite. The Milarsenite thinned that bermuda enough so that he didn't have to use these other methods of getting it in. I feel that insofar as the winter green is concerned, it is important to have a bermuda base in there to support that rye. That's the function that it performs on a winter green.

Question: What is the best fertilizer for bent grass?

Watson: I might mention that the Turf News of Texas, Volume 1, #4 & #5 touches on that subject. I can't tell you exactly how much nitrogen, phosphorus or potash to put on. I think all you need to do is to keep an adequate amount available for the plants. If you are using soluble types of nitrogen you don't want to apply over 3/4 to one pound of actual nitrogen per thousand square feet and I think you need to apply that every 20 to 25 days. I think you need somewhere from 4 to 8 pounds of available P_2O_5 and K_2O each year. That can be applied all at once. The use of nitrogen is the key to successful turf. You can't afford to overstimulate at any one time and on the other hand, you can't afford to under-feed at any time. It becomes a question of dishing it out a little bit at a time. During the summer I believe you need to cut down on nitrogen on bentgrass but not on bermuda because that is when bermuda needs it.

Question: Is there any control or maintenance practice that will lessen Poa annua in bent greens, fairway, etc.

Question: What is the latest information on Rhodesgrass scale?

Watson: I hope that in a short period of time there may be some new information available. I talked to Dr. Johnson about this situation at one time and he told me Chlordane applied twice at the recommended rate checks or controls the immature or crawler stage of the scale. Once it becomes a mature, fully developed scale, Chlordane will not touch it. I believe Dr.

Johnson told us last year that Parathlon, one of the organic phosphorus compounds, is somewhat effective. Parathion is extremely dangerous to handle and man needs to know what he is doing before he fools with it.

Question: How often would you say Chlordane should be applied?

Answer: Every 14 days.

John Scalzo: I used 40% wettable and applied it with about 450 pounds pressure. The nozzle has a point on it and I put that about 6 inches from the ground. Then I waited 14 days and did it again.

Question: When is the best time of year to treat?

Answer: It seems to work in the fall of the year, mostly in September. I wouldn't go out there in the summer because it may kill the bermuda. There are some types of bermuda that can stand heavier doses of chlordane than others.

Comment: Chlordane makes some bermuda brown all the way down to the roots. Don't over-stimulate the grass and get a lot of soft, succulent growth by giving it a lot of nitrogen. The thing you must have is a balanced fertilizer--balanced according to the needs of the plant.

Potts: Within five years we will be treating seeds. We will apply certain chemicals to the soil which the plant will use and kill the insects. Some research is being done on that. We hope in the very near future to have more information on this.

-o-

CARE AND MANAGEMENT OF ORNAMENTALS

A. F. DeWerth
A & M College System
College Station, Texas

If I follow this title, I am at a little disadvantage for I am not too sure what your principal maintenance interests in ornamentals are. I know there are problems and this morning I thought I would go over some of the bigger things which I consider in this category. If I don't hit your particular interests, I will try to allow enough time for you to bring them up.

Today I think the entire field of maintenance has changed considerably, not only in ornamentals, but perhaps in other operations. I presume that most of you in your operations are interested in woody plants. Today maintenance must be kept at the lowest possible cost. So probably the biggest problem is to cut costs and as labor is the most costly item today, it revolves around that. We'd like to help you find a way to cut cost. We know from our contacts in the landscape industry and with nurserymen that no one is sure what his maintenance costs are. I am quite sure everybody thinks he knows but we just are not sure costs revolve today around labor more than any one thing and maintenance is one operation that consumes labor.

Actually cutting labor down depends on two or three things. One of them is the reduction of time that it takes to do a job. I have been in this business about twenty-five years and I can remember when you could have carpet bedding in a park or cemetery without any trouble at all. Labor was about three dollars a day and they could go out and dust these things off every morning. But that has changed. Today we are faced with using the least amount of labor and reducing the amount of time it takes to do the job. There are two ways to do this as we see it. One is to increase the efficiency of the labor and the other is to supplement it with satisfactory equipment.

We are in the business of training men to do this sort of work, but the responsibility is only about 50% ours. If we were to graduate enough men to fill the openings now, we would have to have a class of about a hundred every semester. We graduate about ten every year.

Anybody who deals with ornamentals is at a decided disadvantage because twenty years ago most of our specialized labor was trained by the apprenticeship method in Europe. Today we don't have that. I believe one of the things that has to be considered in this business of intelligent maintenance is a more thorough training of personnel, and the development not only of the personnel you are going to get, but the personnel you already have.

Another thing which bogs us down in this business of maintenance cost is that we follow practices just because they are routine whether they have proven to be beneficial or not. In other words, there sometimes is a reluctance to accept new methods after they have been worked out. There is one thing I would like to mention as far as these cost records are concerned. You can't very well get an accurate cost background by

watching one man do a job for a day because not all men work at the same rate of speed or as efficiently as others. We find the only way you can tabulate definite cost data on any operation is to do it with a group of men under supervision enough times so that you can strike a very satisfactory average. If we know or have that sort of information, we find that very often you can do it with a lot less money and help, but you have to know exactly how you are doing it and how much it is costing.

In the very limited time we have I am going to try and hit some of the high points which we have found (from observation and a certain amount of research) here at the college have aided greatly with the proper maintenance of ornamentals. One thing that is important is soil. I am concerned only with ornamental plants; not necessarily turf. We know one thing that is quite general within the state and that is that the structure of the soil is a particular problem. If you are going to get satisfactory growth on these plants with a minimum amount of attention, there must be a remedy for this problem. The only thing is I can't do is tell you how to solve it. There is one thing that is common to every infertile soil and that is the lack of organic matter. That is pretty general in most of the areas throughout the state. You hear all kinds of talk on how to establish good soil but very seldom do you see any outline of what a good soil actually is. From the standpoint of ornamentals, on the basis of structure, we would like to define it as a soil that has an equal amount of pore spaces between particles as solid matter and the pore space has to be divided into two types of pores--pores that hold water and pores that hold air.

If you can establish that ratio, then you will have a perfect or ideal soil for growing most of the ornamental plants.

There is one way to get this condition. That is with the addition of organic matter. When you have extremely heavy soil, you probably have the right amount of pore space,but it's composed of very small pores which continually holds water so you have insufficient drainage. When you have a sandy soil with a great deal of sand in the soil, then you have too many large pore spaces and you don't have sufficient water retention. Very seldom do we find pure clay or pure sand--we have a mixture of the two. Between these two extremes we have to add varying amounts of organic matter to get the necessary structure to give us good plant growth.

Most of the soils are pretty well run down. In this case it will be a question of adding about 25% by vol-

ume. We are only interested in the top 6 to 12 inches of soil for the growth of most of these plants. This means about 3 or 4 inches of organic matter incorporated with this volume of soil material is used to supply the organic matter inconsequential. We believe that the material that's available at the cheapest price and in the largest quantity is the most satisfactory. The only thing we find in commercial practice contrary to this recommendation is that very often we get fresh undecomposed material. I don't mean fresh manure but such things as prepared sugar can pulp and fresh strat that have not even started the first stage of decomposition and when mixed with the soil, will take out all of the nitrogen to decompose, this type of material. So if fresh material of that kind is used keep this point in mind. It will have to be fed heavily until it reaches a good stage of decomposition and then the nitrogen applied will return slowly. We feel that the structure of the soil is very important in our particular work. Soil aeration has been found to be a very great factor in producing good plant growth, and this aeration in any soil is dependent upon good soil structure.

As far as fertility is concerned, we find that in a good many areas of the state, the use of fertilizers is more overdone than underdone and in a good many instances the wrong material is used. Bear in mind that I am talking about woody plants. One thing we find as far as fertility is concerned is that a great number of soils in the state have a high alkaline reaction. In itself that doesn't make too much difference except when soils are slightly above the neutral point with most ornamentals, plants, the availability of most of the plant nutrients decreases.

Another thing that is going to make this condition even more acute as a maintenance problem is the introduction of so many camelias and azaleas into some areas of Texas. Where you can plant them in an area such as we have in front of this building, in a bed where you can grow them in practically pure peat, and where you have good control over the reaction in the soil they can probably be grown very well. I am willing to guarantee you that you are probably going to have a maintenance problem in the Dallas and San Antonio areas where the pH in the soil is around 8 and camelias and azaleas require a reaction of about 5. There is just no way to grow these successfully unless they are placed in a confined areas where you have good control over the soil reactions.

Another thing we find quite common with maintenance of

soil fertility for ornamentals in many areas is the deficiency of potash. We also find that a good many growers of this particular type plant have been trying to take care of that deficiency with applications of a complete fertilizer. The commonest one used among our people is the 5-10-5 and I think it is the commonest one sold in this state. When you do have a small amount of potash but not an adequate amount present, as you add the nitrogen in the complete fertilizer you increase the vegetative growth on these plants and instead of overcoming this deficiency, you increase it because it needs that much more potash. That's rather general. We know that it is an acute situation because a good many of your ornamental plants act very definitely toward that deficiency.

A question we get from many amateur gardeners is"Why won't my nadinas set berries?" If these plants were fed with potash, they probably would produce more berries. This condition is very definitely a result of potash deficiency. The same thing is true of blindness on daffodils, and decided effects on a good many other ornamental plants.

Another thing that I might mention, that is becoming very general because of the influx of plants like azaleas and camelias is a definite chlorosis, on these plants shortly after they are planted and then a diagnosis of an alkaline soil. This isn't always the cause. More often it is an iron deficiency and as you get farther and farther towards the alkaline side of those plants, you again get the iron being tied up, so this condition is a complication of alkaline soil and iron deficiency.

We find that many growers have been using aluminum sulfate to counteract alkalinity. We also know that in a good many areas there is a deficiency of phosphoric acid in the soils. To most ornamentals free aluminum is highly toxic. The only way you can eliminate getting residual pure aluminum is to have a sufficient amount of phosphoric acid in the soil to pick it up. It is a pretty touchy material to use. We recommend iron sulphate and sulfur because of its quick effect and the long time effect in overcoming excess alkalinity.

One thing that I believe we need in this part of the country, to cut down maintenance costs of ornamentals, is some sort of a program of our own to determine which ornamentals can be used with a minimum amount of maintenance. There is almost a total lack of this type of information that is authentic.

The practice of following many recommendations in garden publications also causes trouble under our conditions. There has been very little work done in this system of the country on ornamental plants. The things that work in other places just don't work here.

The question of what you can grow here in Texas, as far as ornamentals are concerned is not a serious one. I think you can grow anything if you can get water to it. Our main consideration is whether or not a plant will come through a hot dry summer. One thing that builds up the cost of maintenance of ornamentals is a poor selection of the plants used in the original planting. If you select the plant to do a job and you are going to have to perform some operation on it every month, then you have two strikes against you at the start.

I mentioned selection practices a minute ago. If you put in a plant that requires a lot of work, pull it out and put something in that doesn't take that much work. I believe you will have a very definite maintenance problem with the rate of growth of some of our materials. Any deciduous shrub will grow three times as fast under our conditions as it will many other places in the country. As a result, it is going to be shorter lived and it is going to be much larger than it might be in other areas.

This means that when a landscape planting is made, it will not last forever and under our conditions it is going to last a shorter period of time than it might in other parts of the country. That's a maintenance problem. I believe selection of plants in the beginning is going to have a lot to do with the amount of maintenance you will have to do.

The adaptability of any particular plant to the locality in which you are going to use it, is also important. It is not necessarily the environment, but the locality. A striking example of this is with street trees. If you want to see an example of a rather poor selection, live oaks are the predominating street tree used on the campus. Largely because every plant man that has been here for a good many years says that they have to be evergreen to be a good street tree.

I don't think that this is a basic requirement for selecting any plant. We face the necessity of cutting the tops off these trees all the time because of light wires and the bottoms so that the cars can pass under them. This is a constant maintenance problem and it

also does much to constantly spoil the appearance of the tree. I believe you should give careful consideration to the job that plant has to do in the location you want to use it if you are going to do a good maintenance job. It's certainly one of our problems today.

Probably the two best trees we have in the United States for that sort of work are the elms and oaks. Because they have been used so widely, they are practically being eliminated in the more thickly populated parts of the country because they get ten or fifteen diseases. If one doesn't get it, the other one will. Some of you have been working with oaks down in this part of the country and know that this oak wilt business is getting pretty serious.

As far as street trees are concerned, there is a new one which I think will very easily take the place of elms because it is shaped about the same, and that is the Morain honey locust that has been introduced by Siebenthafer in Ohio. It is thornless and it doesn't drop continual litter like the ordinary honey locust. It's a fairly rapid growing tree and it's more or less pyramidal. For this purpose I think it is the best thing we have today.

I believe we consume a great deal of labor unnecessarily in our planting operations. In this country through the southwest I think we waste a lot of time and money trying to plant large plants. Most of them grow rapidly and move more readily in smaller areas. You increase your labor cost tremendously by trying to move a large plant and at the end of three or four years the smaller sized one will be ahead of it anyway. The bigger the plant, the longer it takes to become established. We plant practically 85% or 90% of the plants we use on the campus in sizes that will take a hole 12 inches in diameter. We do that for one reason. The most costly labor problem we have is digging holes. We have a power auger that will dig a 12 inch hole. Two men probably dig 10 to 15 holes a minute with that auger. When we plant stock in the nursery, we can dig holes twice that fast and it cuts down the labor cost. With good soil preparation and the necessary amount of fertilizer and water, such a tree will be just as big in two years as one five times that size at planting time.

Deep watering is necessary and as long as there is a gadget as simple as the one I told you about yesterday there is no reason why this cannot be done. Watering, as far as our plants are concerned, is a very costly

item if you do it the way you have always done it. On the surface we use a gadget called the Waterwand. It is a long aluminum rod about 40 inches long with a breaker on the end. The breaker is merely a device, that breaks up the pressure so that you can put the water on in a tremendous volume and not disturb the surface of the soil and get good penetration. We use that device on newly planted beds for surface watering. You can put it on the end of a hose and turn it on full force and you won't even disturb the smallest particle on the surface of that bed. You do put on a tremendous volume. That's important. I don't care how good that man is when he is putting that water on with any other device, neither he nor you have the patience to stand there long enough for that water to penetrate six inches or a foot. This gadget solves the problem and it lets a man water about 30 times the area he could otherwise do in a day.

With new plantings we use a root irrigator and try to get the bed wet and keep watering until the plants are established. Actually what we need is a breeding program of our own to produce plants that are more resistant to drought than those we have tried to adopt from other parts of the country.

There are three or four things from a maintenance standpoint that are extremely important when you select equipment. These are very often overlooked. The thing we are interested in first is how well the piece of equipment will stand up under constant use. The second is how easy it is to repair. The third is does it do the job. As I mentioned yesterday, I believe we have a tendency to see if a new piece of equipment does a good job on all the operations we have to perform. This is wrong because it will wear out quicker and then we have nothing to do the job this equipment was made for originally. It does one job and does it well and it isn't readily adapted to another job, then try something else to do that other job. Don't try to make one piece of equipment do everything you have to do.

There are two or three things which I believe are important general maintenance considerations. One is that you must have moisture in this part of the country. You may go five years without it when you don't need it, but you had better have it there when you do need it. With many of the plants that I'm talking about watering is a long-time proposition and you just can't afford to lose them because it takes too many years to replace them. Moisture plays a big part.

Another thing we have that is different in this section of the country from any place else is high temperature and high light intensities in the summer months. The only way I can explain it to you is to get very fundamental. You have three, four or five principal plant processes that must go on in a plant or it will die. One of these is respiration. In other words, it is a process very much like our own breathing--if we stop breathing, we die.

The other is the process of food manufacture which we call photosynthesis. Unfortunately, as temperatures increase, photosynthesis decreases and when it gets to about 90 degrees, it practically stops. Respiration can't stop-it goes on day and night and as temperatures increase, respiration increases. When you get to 90 degree or above, that plant is not making any food at all and it is using more than it does at any other time. So you might as well sit back and figure that ornamentals are not going to grow in summer time, or if they do, it is going to be a pretty cool summer. If you keep that in mind, you will know that when you have high temperatures, whenever you feed that grass, you will be wasting fertilizer because the plant can't use it anyway. What you want to do is to keep them alive in the summer time, keep as much foliage on them as possible because that's where the food manufacturing process goes on. Don't be out there cutting any leaves at that time and slow down all your other cultural operations. That is especially true when we get 90 degree temperatures and here they last for two or three months. Last year they lasted that long without any moisture. So that's important. Light intensity is another important thing. The higher the light intensity, the more it makes the temperature situation become acute.

There is one thing that I have noticed from looking at a good many established plantings as far as pruning is concerned. Perhaps some of you know more about it than I do but there seems to be a general practice to keep cutting out the young growth on these shrubs and leaving the old growth go. If you want to plant new shrubs about every ten or twelve years under our conditions, that is a good thing to do. But if you want to prolong their life, keep cutting the old growth out and increase the vigor on them and they will last about twice as long.

Before I stop there are one or two things that I would like to mention that perhpas are alittle different from your work with turf. As far as insect control on ornamentals is concerned, we are not as particular as some people. Parathion was mentioned yesterday as being

very dangerous. The only people killed by Parathion are those who took a bath in it or handled the pure material without the necessary precautions. I think if the man who applies it follows the precautions, there is no danger in its use. The reason I mention it is that it is probably the best insecticide that we have had to date. It does a more effective job on aphids, red spider and other insects we have had to control on ornamentals. Bear in mind that you have to follow precautions or it is dangerous. The trouble with stuff like that is that familiarity breeds contempt. You use a gas mask a dozen times and it hasn't hurt you, so you use it without the mask. That's when you get into trouble. We used Lindane which is the gamma isomer of benzine hexachloride for aphids, beetles and caterpillars.

If you don't want to use Parathion, you can use a material which is sold under the name of Tepp. It has a very small residual effect. It breaks down within an hour and it gives a very good control for red spider, aphids and young leaf hoppers.

We find that the efficiency of these materails is increased by the use of a good spreader. The things we use most widely today are the new chemical spreaders. They aren't particularly new. They came out about three or four years ago. One of them is the PCC and the other is Santomerse "S". You can use them with DDT or with common fungicides such as Parzate, Zerlate and Fermate.

-o-

CARE AND MANAGEMENT OF CEMETERY TURF

B. L. Rouze

Mt. Olivet Cemetery, Ft. Worth, Texas

Shrubs and flower beds are a great problem to a cemetery. When a dear old lady plants a shrub on a cemetery lot, the next six generations want that shrub to stay just the way she planted and no one is to touch it. So it becomes quite a problem no matter what kind of shrub it might be.

I had considerable trouble with crabgrass in my lawn. I had a neighbor who very generously supplied me with

seed. There had been a discussion between my wife and I as to what kind of lawn we wanted. We have St.Augustine in the back lawn and bermuda on the front lawn. My wife likes the St. Augustine and I like the bermuda so every chance she can get, she tells me about the lawn. The crabgrass got in and I told her I would take care of it. I have had to depend a great deal on some of my friends who know a little bit more about bermuda than I do. I called Frank Goldthwaite's store and asked Charlie Gregory about the crabgrass. I got some material and put it in the garage and told my wife not to touch it for she might ruin the lawn. I came home one night and the crabgrass was all out of the lawn. It was pretty well torn up. My wife had used the knee pad and kitchen knife method of getting it out. I haven't heard anything but crabgrass since. My wife has really impressed crabgrass on me. The material I got is still sitting in the garage where I put it.

I can't speak with too much authority on the maintenance and care of cemetery turf because I am not dry behind the ears on cemetery management. I have a very good coach in Mr. King but he has a lot to pour on me and I can only soak up so much at a time. There are a lot of other problems, too. However, I can bring out some of the problems of management and care of cemetery turf.

We hear a lot of people who are very qualified speak on the care and management of turf. I would like to speak on some of the problems of management and care of cemetery turf. The plots in our cemetery indirectly or directly concern a hundred thousand people all the way from grandma to second cousins and each and every one has ideas about this little plot of grass where their loved ones are laid to rest. If they see a fine turf on a park or on the golf course, that is exactly what they want on their cemetery lawn. We want to try and come as close to it as we can. We must depend on you fellows as the specialists who know how to grow good turf to help us keep up with you. So I would like to now go into some of the problems we have in trying to keep up with you.

My first experience with fertilization was to go to the barn, load it up, get a fork and spread it. As I grew up a farmer boy and went to school, I learned more refined ways of fertilizing but I still have some problems in the cemetery. On the blackboard I am going to draw a square 20 x 20 as a representation of one lot in a cemetery. That is 400 square feet. If you will just picture this over a large portion of an area

of 130 area, you will see what I mean as I go along. All the lots are not alike but this is just an example of a lot in our cemetery. One half the lot may be bought by one person and the other half by another person. We will draw a line down through the center. On this lot they are going to erect a monument. This will represent the monument in the center, of the one half. Then this person may erect a monument also in the center of the other half.

In a majority of cases a marker is placed here at the burial. After this marker is placed there may be a ground level vase. A ground level vase is just a container that is sunk in the ground so that one can put in cut flowers at the grave site.

At the corners of this lot there will be a concrete corner post marking the lot on each corner. This concrete corner post is 3 to 5 inches in diameter. We find it to be a very good method of lot marking. You can use a power drill auger, or a hand one. Every cemetery seems to use a different method. The markers are placed on the corners to designate the corners of the lots. There is a number on each one and we find it easy to identify. The lot markers are placed at a ground level. It is nothing more than an ice cream container filled with cement. The markers may be granite or bronze.

On the other side of the lot the same thing is going on. Then we have a ground level vase for the burials and the markers. We may also have a path in here three or four feet wide and we have a large tree growing out in the path with a 30-foot spread. There is also the family marker. All these individual graves have markers. So we have plenty of problems to work out, as you can see.

Aeration is one of our major problems. You can readily understand why it is so difficult to aerate that 20 x 20 plot with the Aerifier.

We have the problem of trimming around the raised monuments and the markers that are at grass level. It takes a lot of time to go around with an electric or gasoline mower and trim these lots. The grounds must be kept in good condition or the lot owners will complain. Fertilizing this area with different types of chemical fertilizers will stain some of the bronze markers.

We come as close as we can to satisfying the people but we can't spend any more money than we make. We have

to find economical means. We have certain rules and regulations for keeping the lots but sometimes the people get a little irked with it and voice their opinions. So I stand there patiently and listen to them because it's my job. I have to deal with these people. That ground is sacred ground to most of them and it is my job to obtain their friendship and cooperation. I love my job of helping these people but we do have all these problems to cope with.

When we have a burial on that lot, we have to take the sod off, open up the grave and take 7 or 8 yards of soil out of the hole. After the burial is made, we must put the soil back in the hole and try and have a smooth, level turf just like it was before. That sometimes creates a problem because we have to get out there with pieces of machinery and haul that soil away.

As dry as it was this summer, we couldn't make a dent in the turf. If we have a lot of rain, machinery of any sort will make tracks in the turf. If you notice tracks down through golf courses and parks, you know how that looks. In fact, there are more tracks made on golf courses and parks than in the cemetery. I find that plants need about the same balance as humans do. If they get food, air and water in the proper balance, they are healthy, but if the balance is broken, they become unhealthy.

In digging a grave we need a 3 by 5 opening. We have the problem of getting the dirt back into that hole so that it will stay put so that we won't have to keep going back and resettling. If it is a vault burial, a cart of fine sand or gravel is dumped in around it so that it can work down around the edges or be pushed down by a stick. Then we fill the area around the vault so that later it won't sink down and leave a hole. The other earth is put back on top until we get up to the sod level. Then the earth is tramped down. You can see that if you beat the soil down and put sod right on it, it wouldn't be much good as a base for the grass to grow on. So we place a little layer of well composted earth underneath the sod and lay the sod on this.

For resodding during the heat of the summer we have a problem. We have a watering system with a small 3/4 inch pipe. However, we cannot depend too much on water systems until the engineer get a flood control program corrected. Until we can get that water, we cannot have ornamental plantings or spend much on watering systems. In putting the sod back we lay it in squares exactly like we took it off. We found that

if the sod is left there without any cover, it will dry out. We sprinkle some fine soil over the sod so the moisture is held there. Usually the grass will grow nice and green and if we have done a good job of tamping, we don't have a sunken plot later.

If that was a box burial, as years go by the box will deteriorate and fill in. Then this whole grave would fall in and we would have to refill the sunken area. To correct that condition our cemetery is using a dry mix of sand and cement. It is placed in the soil on top of this wooden box and serves as a reinforcement.

I have dug down to inspect them and have found that it is just as hard as cement should be. The cement mixture holds the earth up when the box rots and keeps the grave from falling in.

I insist on mowing with a reel mower, wherever, it is possible to use them. We can do most areas with a reel mower and if the markers are set right, it will do the job nicely. By following up with trimming around the edges of the marker makes it look real neat. We can only get so close with the reel mowers and, therefore, we have a great deal of trimming to do. We cut the bunch grass but it seems to pop up over night so we have to use Whirl-wind mowers to get it down.

We have probably in the neighborhood of ten miles of curbs which have to be trimmed. I think a curb is nice and it is no harder to trim around the curb than it is to trim around the sides of the roads. We fixed up a little gadget on the tractor which is nothing more than an arm. We have a small Gibson tractor. On the front end of this tractor there is a little arm that goes out and we just use ordinary farm equipment, to hold it. This arm works up and down and will trim around the curb. This coulter comes along and rolls in back of the curb and cuts the rough edges of the grass off. I think we have covered the entire area in a couple of days.

The aeration problem troubles us a great deal more than fertilization. We have a problem of the metal markers in the cemetery and watching that our fertilizers don't stain them. We try to maintain green turf as long as possible. I have tried ryegrass and I have some beautiful spots of ryegrass. I will put them up against any green turf that I have seen. They are little squares about the size of this lot. I sowed the seed and put a fine silt soil over it, watered it and it came up in a perfect stand. Where it is broadcasted over the area, we usually get a fine crop in

back of a monument, a tree and on top of new graves. However, the rest of the grass is sparse and it doesn't look very good. Where I want a nice green grass, I sow ryegrass and cover it with a fine silt soil and get a perfect stand.

I have a million and one things to do besides maintaining turf but I have a fine coach in Mr. King. I don't know what I'd do without him. I have so many problems that I am a little confused sometimes and expect to be, until I have gained necessary experience to cope with them. We in the cemeteries are begging and asking for the ehlp of you fellows who ar' growing fine turf. We need machine operators, equipm' t operators. Gradually we are getting pieces of equipment that will do our job and we are receptive to almost anything. We want something that will ease our job. We will spend money providing we have it. We have to keep pretty close to the golf course people and park people because folks go out and see green grass in the park and want it on their cemetery lots.

A golf course can be moved, but once a cemetery is established, it remains pretty much as it is for as long as time exists. So we must work out these problems. We need all the help we can get.

-o-

CHEMICAL CONTROL OF CRABGRASS IN SPECIAL PURPOSE TURF

J. R. Watson, Jr.
E. D. Cook

Dr. Elton Cook, Superintendent of the Kirbyville Substation is unable to be here this morning. I want to report the results of tests conducted on the use of certain chemicals for controlling crabgrass in Bermuda grass turf during 1951. The tests were located at the Texas Agricultural Experiment Substation No. 22, at Kirbyville, Texas. They were a part of the national crabgrass trials coordinated by the United States Golf Association, Green Section. They were supported in part by a grant from the American Cyanamid Company, through the U. S. G.A. Green Section.

Crabgrass is one of the major weeds infesting turf areas during the spring and summer. Several materials are now available which are selective for crabgrass. However, all will cause serious damage to permanent turf grasses if handled improperly.

MATERIALS AND METHODS

The area selected for the tests was an old abandoned field. Bermuda grass constituted approximately 65 to 70 percent of the initial vegetation. A heavy infestation of crabgrass has been present in past years. The area was mowed at a height of 1-1/4 inches early in April and an application of 10-5-5 (1/2 organic and 1/2 inorganic nitrogen) at a rate to supply two pounds of nitrogen per 1,000 square feet was made.

The plots were irrigated as often as necessary for growth of the grasses present. Additional irrigations probably were desirable, however, the water well located near the test area went dry in July and it became necessary to haul water in by truck to keep the tests going.

A 4 x 4 latin square design was used for each test. Three plots were treated with the chemicals. The fourth plot was a check.

The number of crabgrass plants per square foot was determined by the use of a square foot grid quadrat. Three random sites per plot were selected and staked. All counts were made in the same location. Counts were made prior to the initial application of the materials and 7 to 10 days after each treatment. Estimates of the degree of injury to the permanent grass were made 3 to 5 days after each treatment.

The chemicals used and the rates of application were: phenyl mercuric acetate (PMA) (10%) at a rate of five pints per acre; potassium cyanate (KOCN) (91%) at a rate of eight pounds per acre; and sodium arsenite ($NaAsO_3$) (75%) at a rate of one pound per acre. One pound of wetting agent (Igepon AP Extra Concentrate) was added to each herbicide in 100 gallons of water.

Three individual trials were conducted:

Spring: The first application was made when the crabgrass seedlings were in the 2 to 3 leaf stage. Two additional treatments were made at 7 to 10 day intervals.

Summer: The first application was made when the seed heads were approximately one inch out of the boot. Two additional treatments were made at 7 to 10 day intervals.

Spring and Summer: The first three applications were made at approximately the same time as the spring

treatments, and we followed in late summer by three applications at 7 to 10 day intervals on the same plots.

RESULTS

A summary of the results of each of the three series of tests are reported in Tables 1, 2 and 3. Using the number of crabgrass plants per square foot present on each plot before treatments were applied at a base, the percentage reduction in crabgrass after each treatment is reported:

Table 1 Percent reduction of crabgrass in the spring test

Chemical Used	Before treatment		After treatment	
	Date of reading			
	5/11	5/23	6/4	6/12
PMA	100	79	95	97
KOCN	100	83	93	97
NaAs03	100	74	84	96
Check	100	21	51	62

Table 2 Percent Reduction of crabgrass in the summer test

Chemical Used	Before treatment		After treatment	
	Date of reading			
	8/17	8/20	8/31	9/10
PMA	100	27	57	73
KOCN	100	32	75	82
NaAs03	100	30	92	97
Check	100	20	40	53

Table 3 Percent reduction of crabgrass in the spring and summer test

Chemical Used	Date of reading: Before treatment		After treatment				
	5/15	5/23	6/4	6/12	8/20	8/31	9/10
PMA	100	79	88	94	94	99	99.8
KOCN	100	85	93	98	97	99.7	100
NaAs03	100	81	89	96	96	99.9	100
Check	100	-7	46	60	66	74	81

DISCUSSION

The data indicates that spring is the best time to eradicate crabgrass. When crabgrass was in the seedling stage, each chemical used was effective in reducing the stand. Three applications of either chemicals appeared necessary to do a thorough job of eradicating crabgrass. There appears to be little necessity of more than three applications, providing treatments are begun early enough. However, additional treatments will give almost 100 percent control.

Sodium arsenite seemed to be the most effective in this experiment against mature crabgrass, although potassium cyanate will render satisfactory control. Results by other workers at other locations indicate, however, that potassium cyanate is somewhat more effective against mature crabgrass than is sodium arsenite and that phenyl mercuric acetate is somewhat more effective against seedling crabgrass than eigher potassium cyanate or sodium arsenite.

The degree of injury to Bermuda grass was recorded. All chemicals produced some temporary injury, but no permanent injury to Bermuda was noted. A temporary browning that lasted for only 4 to 6 days was evident. Such temporary injury to permanent turf grass should not preclude the use of chemicals to destroy crabgrass.

Chemicals will eradicate crabgrass but reinfestation will occur unless proper management practices--such as

fertilizing, proper watering and mowing--are followed. On properly managed turf, once most of the crabgrass is eliminated the desirable turf will be vigorous enough to fill in and compete favorably with crabgrass. Established turf, properly managed, will seldom be infested with crabgrass.

For the experienced user, the cost and availability of the product would govern the choice of herbicide. For the home-owner, or those less experienced in using chemicals, potassium cyanate probably will continue to be used because of its non-toxicity to man or animal.

Now a word about mechanical control of crabgrass. Sometimes a situation occurs where chemical control is not practical. The use of mechanical attachments--combs or rakes--that fit right on your mowing equipment to lift the crabgrass runners and seed heads up, so that, they may be cut by the mower is still a good method of reducing crabgrass infestation. This type of program coupled with proper fertilizing and controlled watering--I can't emphasis these latter factors too much--will go a long way toward ridding an area of crabgrass.

Question: Is there any particular time when you should water?

Thank you, perhaps I should cover watering a little more in detail. We find that the use of excessive water definitely encourages crabgrass. Turf should be watered only when it shows signs of wilting. Just when this will occur is going to depend on a number of factors such as the type of soil, its water holding capacity, texture, structure, permeability and other physical soil properties as well as the height of cut and degree of usage.

As far as watering after chemical treatment is concerned I would withhold all water for atleast 48 hours and preferably 72 or longer. All these chemicals are "contact" killers, in other words, they have to come in contact with the leaves--this is the reason for using the wetting agent, its actually a "sticker". For this reason water should not be applied for 4 to 72 hours after using the chemicals. Should it happen to rain the treatment will have to be repeated.

Remark: You must have a dry field to begin with. We put out one application on our football field and had extremely good results. The second application was put on wet turf--the maintenance man had watered heavily the preceeding day. Although it was extremely hot

when we put out this second application, you could tell where the sprinkler had been--there was no control where the grass had been watered. With another treatment it rained within 24 hours after application and the effectiveness of the chemical was materially reduced.

Thank you gentlemen. I would like to mention that the results reported this morning will be published as a Texas Agricultural Experiment Station progress report. It will be availabe upon request. (The number and title of the progress report is T.A.E. S. Progress Report No. 1450 - "Chemical Control of Crabgrass in Special Purpose Turf".)

-o-

"WHAT'S NEW IN TURF WEED CONTROL AND SEED BED PREPARATION"

W. E. Zimmerman
Turf Specialist
American Cyanamid Company

Introduction.

It is a pleasure for me to be on your program here at Texas A. & M. College. You have had an excellent Turf Conference, the speakers have presented very useful information on turf maintenance here in Texas, and shown you results of turf practices in other sections of the U. S. and Mexico. As my part of the program, I would like to discuss with you, "What's New in Turf Weed Control and Seed Bed Preparation".

You have heard a lot about turf weed control in recent years, and some of the materials that have been used in this program. You probably will hear a lot more on this subject in years to come. Your own Dr. Jim Watson has worked closely with several of the newer chemicals while taking his graduate work at the Pennsylvania State College. He has presented his 1951 results to you on how some of these materials work here in Texas, and College Station was one of the nine locations that completed a set of experiments with several of the more promising chemicals useful for crabgrass control. These three chemicals included in the National Coordinated Crabgrass Trials were PMA; Potassium Cyanate; and Sodium Arsenite. Igepon, a wetting agent useful in weed control as a spreader, was

selected by popular choice. Texas A & M, was one of the seventeen original cooperators staring this trial, in cooperation with the U.S.G.A., Green Section, who acted as the coordinating agency in this test.

1951 Turf Weed Control Results.

Dr. Watson has indicated to you that PMA; KOCN: and Sodium Arsenite, in early, early - late and late season tests are effective for crabgrass control. A summary of the coordinated trials from nine locations, from Rhode Island to California, presented at Mr. Al Radko, U.S.G.A., shows the PMA solutions to be slightly more effective for early use on crabgrass seedlings Potassium Cyanate in these tests also kills crabgrass seedlings in spring treatments but is more effective in the early - late series, and in several late summer and early fall applications at the pound rate used as a standard in the coordinated studies in 1951. Sodium Arsenite was also effective ata pound per acre in this trial but during dry weather was more severe on the turf grasses. Where there was ample moisture in the soil at time of treatment this chemical gave a satisfactory crabgrass kill. In the use of any of these three chemicals, soil moisture and temperature have to be considered to assure satisfactory results. PMA solutions at 5 pts. peracre applied with 100 gal - lons of water, was also effective in late treatments and in early - late combinations, but wasn't as satisfactory on maturing crabgrass as potassium cyanate.Dr. Watson's work here in Texas shows KOCN to be effective for controlling crabgrass in Bermuda turf in all stages of growth.

New Dry Formulations.

During the period from 1949 to 1951, several dry formulations have appeared on the market for crabgrass control. It is known that phenyl mercuries, sodium arsenite; and several other materials can be applied dry. Vermiculite, volcanic ash, are used in applying the PMA materials. Another important chemical in turf weed control is 2,4-D. It can be applied in fertilizers using spreaders to make the applications. In some cases, especially with the phenyl mercurials, the two materials can be applied together. Potassium cyanate, during 1949 trials at the Winged Foot, Golf Course in New York, was applied with Milorganite. Fall feedings were split into 600 lbs. each. A 25 percent KOCN dust was mixed with the activated sludge and applied at a 16 lb. per acre rate. A series of three treatments were made at 10 to 14 day intervals. A 1 lb. (technical) rate of the amine form of 2,4-D was added to the

first Milorganite -KOCN treatment for broadleaf weeds. Applications were made on a fairway badly infested with crabgrass, knotweed and some broadleaf weeds late in the summer and early fall on this schedule. The results were encouraging enough to carry on further experiments with this method of applying potassiun cyanate. Dr. O. J. Noer, selected 12 or more heavily infested sites for a series of studies during this past season. He has shown you pictures of the results obtained by this Milorganite -KOCN combination and they prove that this is an excellent method of controlling crabgrass and other turf weeds and at the same time giving the grasses additional fertilization required for good growth.

Other tests with 10 and 25 percent dry dust formulations by our field staff and Rutgers University in New Jersey were conducted during this same period from 1949 to 1951. These dusts in shaker-can applicators or in mixtures with dry soil as Dr. Robinson has used in the Tifton, Georgis studies, all give somedegree of crabgrass control. The New Jersey studies indicate that these dusts perform best when a wetting agent is added. They conclude in a recent report that dusts properly formulated show a lot of promise for crabgrass control.

Watering Can Applications.

You can use a waterin can for applying chemicals for weed control. Such materials as the PMA solutions; Sodium Arsenite have been used successfully. Now from experiments conducted over a wide area here in the States and Canada, this technique can be used to apply potassium cyanate. The trick with KOCN is to keep the percent solution strongenough to be effective and use lots of water to assure uniform distribution. Between a o.2 to o.8 percent solution is effective for crabgrass and chickweed control on both northern as well as southern grasses. Several treatments are required during the season for complete control of these weeds.

Seed Bed Preparation.

There are many other materials being tested further for turf weed control such as Endothal; IPC; CMU; Maleic Hydrazide and Premerge, etc. You will hear more of these chemicals in the future. The mechanical devices such as crabgrass rakes, mats and brushes are also important in any well rounded weed control program in turf. The quality grasses that have been developed in recent years are showing weed resistant ability and all of this is a stop in the right direction. How to get these better grasses established

properly leads us to the next part of this duscussion, "HOW TO HANDLE THE SEED BED PREPARATION?". Seeding on the best foundation possible is important. We feel that a weed-free soil is the proper foundation on which to build healthy turf. This can be accomplished by several methods. Steaming the beds; chemicals, that form gases; --- also certain chemicals that break down into fertilizer elements such as calcium cyanamide. These materials all have been used and are gradually replacing steam. You are no doubt familiar with most of these materials and especially calcium cyanamide, the material that is used extensively in the south for tobacco bed sterilization. AERO Cyanamid, in granular form is also showing much promise for sterilization of turf seed beds in various sections of the country and I want to show you some recent pictures to illustrate these results. The slides will tell the story and I'll comment briefly as we go along.

The first several pictures show Cyanamid being applied at 35 and 50 lbs. per 1000 sq. ft. on plots at the Rhode Island State College. Dr. DFrance made seedings at time of application of Cyanamid; a week after; two weeks; and three and four weeks after he applied the Granular Cyanamed. As the waiting period lengthens, the grass stands are a better and less and less crabgrass and other agricultural weeds are showing. Here is the check or untreated area and you can see the difference.

As you can see from these pictures, AERO Cyanamid, can also be used to get areas prepared ahead of seeding Bluegrass over Zoysia or other nursery grown grass as shown here on the Beltsville, Md. plots. This is Dr. Scotty Forbes standing on an over-seeding of Bluegrass Cyanamid is used in this seed-bed preparation at about a ton to the acre. You can see the effect of the nitrogenon the grasses and note the absence of any weeds in this area compared to the untreated area where the men are standing.

The following slides show Dr. DeFrance and Dr. Fred Grau, talking over the use of Cyanamid at 13 to 15 lb. fpr treating soil for top dressing putting greens. The Orange Lawn Tennis Courts in New Jersey also use this method for preparing their top dressing and this slide shows the condition of the turf.

Here is the number 15 fairway at the Baltusrol Golf Course in New Jersey. Ed Casey used a total application of 2500 lbs. of Granular Cyanamid in preparing the seed-bed for a Merion Bluegrass seeding and 1500

lbs. for a Bent seeding on number 14 fairway. He applied Cyanamid in the middle part of July and made the seedings around the first apart of September. This picture was taken in November.

In using Cyanamid for preparing turf seed-beds, a waiting period is required. This will vary from about two weeks to three or four as you have seen in the pictures. We are now developing a method of testing the acted soil and our Stamford Laboratory are encouraged with this test. On a fairway on Mr. Casey's course which he treated during 1951, we were able to get readings which alowed for safeseeding after two weeks waiting. We hope to improve this technique further as it cuts down the longer waiting period.

A few helpful suggestions in the use of Cyanamid for seed-beds are as follows; Have a smooth seed-bed when Cyanamid is applied; Use between 35 and 50 lbs. per 1000 sq. ft. or as required for your own conditions; Broadcase evenly and work into the first 2 or 3 inches of the top layer; Apply water to assure breakdown;Roll lightly to have granules in contact with the soil; Wait two to four weeks before applying grass seed;Keep the new seedlings moist to assist germination; Keep the new grass moist during dry spells to allow proper rooting.

Thank you gentlemen for your attention. It has been a pleasure for me to be here with this group and with Mr. Jamie Morris, the Agriculturist for American Cyanamid Company in your area. He would be glad to assist you with any problems or further questions about the use of our materials. Dr. Watson no doubt will be doing some further testing with Cyanate and Calcium Cyanamid this year.

-0-