FIFTH ANNUAL TEXAS TURF CONFERENCE

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A AND M COLLEGE OF TEXAS

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WEST POINT LAWN PRODUCTS
West Point, Pa.

WELCOME

D. W. Williams
Vice Chancellor, Texas A & M College

I didn't get to see the Chancellor this morning, but I do want to express his regret at not being here. This is the week of the hearings both before the Senate Finance Committee and the House Appropriation Committee on the A & M askings for the coming bi-annum.

The condition of our budget looks very good at the present time. This year for the first time the last legislature provided for a legislature budget board. They have gone into the question of appropriations for the various state institutions in a more intelligent way, with a sounder approach than has ever been within my experience. I think there is a real need and I think it is a real attempt to eliminate duplications, and within the state institutions to see that duplications are done away with.

Our own appropriations for the experiment station and the extension service and forestry service which are the three in which I have primary concern, are in pretty fair shape as far as the recommendations of the legislature budget board are concerned. The main college is not in very good shape. Naturally on account of the military situation they have made some estimates with regard to decreases in enrollment and the budget for the main college is based strictly on enrollments. We are not in agreement at all that the enrollment will decrease to the point that is now estimated. I think that since it is a military school and having given military emphasis all through these years, there is not very much likelihood that it will decrease to the point that is now estimated. I thought you might be interested in just that little view of how our appropriations look.

I think it is quite beside the point for me to spend any time bidding you welcome. I do want to say that we are very happy that we have this building. We think it is a wonderful one and we believe that you can now come here with a great deal more comfort than in the past and it is a great thing for all our students. The building was finished this past summer. This is the first use that has been given to it. I am not going to take more of your time. I think I had the pleasure of bidding welcome to you the first time this group met here. I am very glad to have been given a chance

to do it again on the occasion of your 5th meeting. I hope that the progress that has been made is satisfactory. Certainly from our point of view we do appreciate the cooperative spirit and financial aid that has come from this group to promote the work here at the college. You are certainly welcome and I hope your stay will be enjoyable. If we can help you in any way, feel free to call on any of us.

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FOOTBALL TURF FROM A COACH'S POINT OF VIEW

Harry Stiteler, Head Football Coach
Texas A & M College

This is a topic that is very interesting to me, but I can say everything I know about turf grasses in a few minutes. Nevertheless, I am deeply interested in this subject.

I might say that to me turf is divided into three important parts. One of them is will it eliminate injury, second will it allow efficiency of effort on the field, and, of course, the third which is highly important to you also is in regard to your pocketbook. We are interested very much in the elimination of injuries of all types. For instance, we want the field itself to be smooth, We want a kind of grassy situation there that will not cause the cleats to hang in the grass, something that won't be placed on the grass in the way of fertilizers that will cause infection to any scratch. If we can eliminate those things on a field, I think we will be able to eliminate things to football that are harmful. I think we will find that we have more injury in football from the field itself than we actually do from contact. That may sound strange, but I believe this can be borne out in our work.

As far as the effort is concerned, we have tried to get a turf that is soft, one that is spongy, that is not only soft when you fall on it and won't cause abrasions but at the same time will be bouncy enough so that if a boy puts a cleat into it he can really get going. If a grass is too high, then it is going to eliminate efficiency so we try to get the grass short. I recall that we have played O.U. for some years at Norman and two years ago it was the best field that I have ever placed my foot on. At that time

they had a grass that wasn't more than ½ an inch high, yet it was like a carpet. I don't know what they did to get it that way, but it was really in good shape. We have made every effort to see if we couldn't improve ours.

The last thing I would say is your pocketbook. I have been a believer that if something looks nice, people feel a little bit better. I feel that if the grass is good and green, it will look a lot better not only to the spectators, but to the boys as well.

Let me show you something here in the way of shoes. This is a shoe that we call the game shoe. Notice the round cleats. They dig in a little bit more. We use them for a game because we will play just one day with it and work out the rest of the time with another kind of shoe. We noticed that some years ago when wearing this kind of shoe we had about seven knee injuries. We think that the knee injuries were caused by a shoe of this type. As that toe dug in, the grass didn't release enough so that with a little bit of a twist, we had a knee injury. Of course, the knees were all worked on and came out satisfactory.

Since that time we have come to this type of shoe entirely. I am not selling any one shoe, but I am trying to give you an idea of what we have done. This shoe has oblong cleats. We have completely eliminated all of our ankle and knee injuries with this shoe. Both the backs and lineman wear this shoe five days a week and then put the lighter shoe on for Saturday. As you see, it is heavier with a thick sole. It is a little uncomfortable to the player to wear but we want to eliminate the injuries.

I told you that I didn't know anything about turf. I would like to find out more about it. I used to play golf a little, but I think that is past too. But I will welcome any questions that you have in the way of the football game.

Question: If that shoe is satisfactory for practice and eliminates knee injury, why don't you use it for games?

It is that one little point we brought out of efficiency. Everybody is seeking to eliminate weight in the ball game. This shoe is quite a bit heavier than the game shoe. If everybody on all teams would wear this shoe, we would be all for it.

Question: Is there a standard procedure?

No, we have nothing standard in this game of football.

Question: One of the heads of athletics at the University of Pennsylvania said that the Number 1 blueprint on an athletic field is color. The first consideration must be appearance and the hell with the turf. That is his opinion. Do you feel that way?

I would say that I think the color is fine. I think you must have it. However, the first thing I want to do is to take care of the boys. I don't know much about grasses. The only two grasses that I am familiar with are St. Augustine grass and plain ordinary bermudagrass. St. Augustine won't do on a football field because the root system is shallow and a cleat would stick in it and cause all kinds of injury.

Question: What is your attitude about rolling fields before games?

I do want the field to be as smooth as possible for a game but I don't believe we have ever asked them to roll it right before a game.

Grau: This seems to be a very important thing and yet nobody that I know of has given any degree of attention to developing superior athletic field turf. There haven't been any coordinated requests from the athletic coaches association. I don't know if there has been any great amount of tax money going into this kind of study. I would like to know your ideas on that and where do you think this support will come from. We are interested in it, but we are privately financed.

That would be a hard thing for me to answer because my boss is sitting right down here. We are very much interested in the work but I doubt if an institution like ours would finance a study.

Grau: It seems to me in going around the United States that there is practically no coordination between the coaches and the people of the University or College that are actually doing turf work. They go two different ways and the people who know turf are never asked to help on the athletic fields.

Comment: In the last few years there has been a lot of work and money put into the athletic field here. I don't know how much of our work would be classified as research, but we have helped.

Stiteler: We would really appreciate anything you could give us in the way of suggestions. It has certainly been nice being with you and I hope that if you have any time this week you will stop by and watch us in our spring work. We start practice at 5 o'clock.

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MAINTENANCE OF TURF ON FOOTBALL AND ATHLETIC FIELDS

F. G. Wright, Supt. of Parks
City of Dallas

I want to say that the parks of Dallas have improved very much from these turf conferences as well as the golf courses. We used very little fertilizer in the parks up until these turf conferences started. Now we are using more. Last year we used about 50 tons of commercial fertilizer on them and the results have been very gratifying. We had less weeds and foreign grasses and the turf is much better.

It is difficult to grow grass on some of these athletic fields that have been used excessively. For instance at Dal Hi Park we have a bowl and they play as many as ten games a week. You can't take care of a diamond properly when that many games are played in one week. We don't have a chance to grow it as it should be. In September the games are fewer so we have a little better opportunity to water this diamond. After we water it, we run the Aerifier over the field, water and fertilize and we have about six weeks growing season after they stop playing ball. It is wonderful how the grass comes out in such a short time. We have very good turf when the season opens in the spring.

At Dal-Hi Stadium they asked for help. In 1948 the school board was interested in improving the turf at the field. At different times soil had been added. Bermudagrass was almost extinct. It was infested with crabgrass and other foreign grasses. The soil was packed very hard. In January the field was plowed to a depth of ten inches. We tried to loosen the soil with a tiller, but it was so hard that we couldn't. The field was graded to the proper oval. We didn't plant bermuda seed until about the first of June which was about six weeks too late. About 50 pounds of bermuda seed was planted. The soil was thoroughly soaked and then watered lightly as needed. The results were

a good stand of bermudagrass. The field was fertilized three times and when the season opened, they had a very good turf. Last spring the Aerifier was put over the field several times and the results were very good. The school board fertilized twice last summer and when the football season opened last fall, they had less foreign grasses and fair turf. I think the turf filled up very well considering they played 50 to 60 games of football in one season.

Last fall a year ago we graded and planted bermuda at a park which contains over 100 acres of sod. We used the old method of planting grasses. We planted in rows of 2½ feet apart and dropped the sod in the rows about 18 inches apart. This area was fertilized, mowed throughout the season. The area was almost covered with turf by fall. Previously this area had a good stand of Johnsongrass. Very little Johnsongrass exists now. This park has a children's play area also.

We fertilized an area that had a good stand of bermudagrass and was also covered with white clover. The sun burned the clover and bermudagrass. After the rain, the bermudagrass recovered, but the clover did not. At the end of the season we had a good turf on that area.

On the football field at Dal-Hi, we had heard it discussed several times about using coarse sand on greens and fairways. Would it be advisable to use a coarse sand on athletic fields, Dr. Grau?

Grau: You can carry that coarse sand on an athletic field to extremes, I think. There has been some of that done and O. J. saw that up at Mitchum Field at West Point. I think they used so much sand that they got it a little bit too loose. The grass wasn't rooted down in there well enough and it kicked out. You have to do that rather carefully in order to get the right amount and still maintain high stability in the soil and never to the extent that the grass could kick out or have any of that sand put in there in layers. If any sand is added, it should be thoroughly mixed in to the soil so that you have a uniform soil condition.

Wright: I would like to say a little on keeping equipment in good condition. A few years ago we had one man in charge of the equipment. Mowers were neglected as he was more interested in trucks and automobiles. The department was reorganized and the mower shop was moved into a separate building and was put in charge of one mower mechanic. He was given trained helpers

and the machinery needed to operate the shop properly. When the grass cutting season was over, all mowers were brought to the shop, each was dissembled, each part steam cleaned and examined. All parts that needed replacing were replaced. The mowers were sharpened, reassembled and painted. When the season was over, the mowers were in good condition and gave little trouble through the season. We are able to keep better operators. These operators are trained to properly lubricate and adjust mowers. They work a certain amount of time in the mower shop during the winter months. They learn more about the working parts of mowers. We keep the mowers properly sharpened when needed and get longer service out of them and they do a better job of cutting the grass.

Question: On that field where you played so many games did you put ryegrass in there in early spring.

No, we did not. I think that is harmful to the grass. I don't know if I am right, but it is my opinion.

Question: Do you sow ryegrass into the football fields?

Some of the fields we do. We did very little sowing this year and it was fortunate that we didn't because we had very little rain.

Question: What do you cut your baseball diamond infield with, at what height?

We cut about 1½ to 2 inches. Sometimes we mow it a little closer than that.

Question: Do you use any kind of artificial watering in the fields?

Yes, we do. In Dallas for several years we have had a shortage of water and that cut our water down to a certain extent.

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MAINTENANCE OF PARK TURF

A. L. LaGasse, Director of Parks
Wichita Falls, Texas

In Wichita Falls we have an odd situation. It is some thing that borders on low budget and high maintenance. I think that is what most of you are concerned with. Some of you may have so much money that you don't worry about how you mow your grasses or how much edging you do. We are primarily concerned with the mowing operation and the redesigning of our property. Our property is scattered over the city; we have 68 different sites and that makes it rather difficult to maintain. Formerly we had been mowing with 38 18-20 inch mowers, two three-unit gangs and five sickle mowers. The sickle mowers did the jobs that they could not possibly do with the 38 18-inch mowers. They let the grass get knee high, cut it with the sickle mower and then go out with a hay rake. We didn't bale it and sell it, but we hauled it away and burned it. There was more grass than we could properly maintain. Actually we have only 32 laborers with 38 mowers. You can see that it isn't economically feasible. You can't operate with a mower set-up such as we had.

The trouble, as I saw it, came from the fact that the choice of equipment was poor. It wasn't the lack of money so much as it was the lack of correct equipment. When I was working for Mr. Urbanovsky we had a three unit gang. One of the units almost hit the man on the back of the head. The reason was that the area we placed the man on was so rough that the mower couldn't maintain the speed needed. When we speak of maintenance of turf, you must think of both maintenance and design. The two are very closely related. We are now in the process of redesigning our parks and taking out our manicuring. We did some figuring and we came to the conclusion that tree wells, for instance, could be eliminated to some degree. At least we cut the average amount of edging down to about 84%. We fillod in the wells and allowed the turf to grow to the base of the tree. Tree wells are valuable when the tree is young. When you plant it, you put a tree well in so that you can water the tree. But it is a very expensive situation. Every tree in the Wichita Falls park system had a tree well and we just couldn't keep up with it.

We had a wet year last year and it made an unusual set up. We had a flood and got into serious situation with mosquitoes. The reason again comes back to the grading

and fill. Even an arid region should have good drainage. It is necessary now to go to the trouble of purchasing a bull-dozer and a grader. Those are two pieces of equipment that are very expensive, but we must grade and fill all our acreage. There isn't an acre that is in good condition or that we can get any speed on. They slow the mower down. I think it is absolutely necessary to get a smooth surface so that you can obtain a speed with your mowers.

We are placing our sidewalks on the curbs. There is no grass strip between. That will cut down 2/3 of our maintenance and it will save wear and tear on the mowers. We are also setting up mower teams. We are reducing from 36 men to 14 men. We hope that next summer we can mow all our parks with the 14 semi-skilled laborers. We have also raised the pay. We can afford to do that if we use less men.

On with mowing operation we had trouble trying to mow around the numerous beds. We have done two things there. We have eliminated many shrub beds. That is a hard thing and we had some trouble with the Ladies Club. I spend half of my time at the Ladies Club because we take out plants and fill in with turf. We can mow at a greater speed. Of course, if you elininate beds, you eliminate a lot of edging. We are trying to choose plants and shrubs that will shade out grass. We put a good solid shrub in. We want the mowers to be able to mow underneath it so that you won't have an edging problem. We have a few shrubs that we can do that with up there. We are trying to move our shrubs back from the roads and make a larger bed. We are making these larger beds to allow clearance between the shrub and the edge so that a man can work in that bed. We are designing them so that we can use a power edger. If they are far enough back from the road, we use oil and put a light film around the edge. Of course, that doesn't look very nice compared with shears but we don't have the money, so we must do it. It looks bad right at first, but after you do it quite a while, you eliminate that problem. We use oil on all of our posts.

I think the primary thing in turf maintenance is the choice of equipment, good grading and finish. It was impossible to mow all of the parks with the equipment that we had. So we concentrated on the edge and then did the best we could in the center. That sounds a little odd. We know that the first impression is the best one. Most people saw the edge of the park. We don't have a good recreation program as yet so there

weren't too many people out in the center. We spend much time and effort from the curb out to 50 to 100 feet in the park because that is what the people see most. Now several times I have noticed that the men have a tendency to mow the center because that is less trouble. They let the edge go and often times the grass will be hanging over the curb. I think that is the biggest mistake we have made and is the hardest thing to try to get the laborers away from. Mow the edge, do the best job and then proceed to the center. We received many favorable comments from the people simply by taking care of the edges.

I am not going to try to cover our cultural practices very much. However, in the spring at Wichita Falls we get infestations of goat heads and some grass burrs and we have had quite a bit of trouble in the past trying to keep down the weed population in the spring. After talking to some of the men, I found out that they set their mowers in the spring to cut about one inch. As the summer progressed, they raised the mowers every two weeks. By mid-June their grass was 2½ inches tall. It is more helpful to the grass if it is taller but you can't do that on the golf course. In the parks we try to get it at least two inches high. We raise it up gradually, you will find that the grass is good and thick.

For work in some of our regions we do have to water. We are trying to put in a watering system in 8 of our parks. Every Thursday night we have a school for any of the men who are interested in learning about maintenance. We want the men to understand why we want deep watering. In one case we had to fire the man simply because he simply refused to do what we wanted. It only takes an hour every Thursday evening and they are trying to learn what they are doing. We have also effected some promotions and we are getting good results from it.

Question: Have you tried borax compounds?

No, we haven't. We have on requisition some chemicals that we are going to try.

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FINANCIAL BENEFITS DERIVED FROM GOOD CEMETERY TURF

Dick King
Mt. Olivet Cemetery

I know some of you are wondering what business a cemetery representative has appearing on a golf course and park department turf meeting. The cemeteries are very much interested in good turf for appearance of the park as a whole. In the last four or five years we have gotten invaluable information from this turf conference, from Texas A & M and from her sister college in Oklahoma. It has helped us toward developing a better turf. Up until 1945 we knew we needed grass but we didn't know how to get it. Bermudagrass to most people was always in the way. I was a farm boy raised on a farm and we were always trying to get rid of bermudagrass, Now in the cemetery business we are trying to grow it.

I will give you a little history of how our cemeteries came into being. I think back in the pioneer days of our country would be far enough to explain a little bit about our cemeteries. In our pioneer days we moved west by leaps and bounds and in each leap and each bound we had to organize a cemetery. Each little community all the way across the nation had to stop and establish a little cemetery. In most cases they set aside from one to fifteen acres and put a little barbed wire fence around it or some stone or something like that to distinguish it from the timber land. Everybody in the community had access to the cemetery. They started dividing the cemetery up into lots and the fellow who owned the ground would sell the other members of the community a small lot of ground that they could call their own family plot. As long as they were in the community they used that small plot, but in so many cases they continued moving west until they ran out of a place to go and stopped at California. Many of you who have visited California can readily see what the westerners have learned from the easterners in the way of developing cemeteries. They started out in the east with little graveyards and wound up in the west with nice, beautiful parks and cemeteries. Progress in the development of cemeteries has been as striking as it has been in transportation. Believe it or not, if you look at one of the little cemeteries in Boston, then look at Forest Lawn Cemetery in Los Angeles, you will believe me. There is so much difference in the appearance of the cemetery and

the way it is organized.

In our modern cemeteries we are trying to give what we think the public likes. It is the same thing that our country clubs, municipal courses and parks are trying to do. However, in our case as in the country clubs, they must pay for it. We organized two types of cemetery. One is where we permit a family memorial that sits above the ground; the other that we only permit the flush tablet that sits flush on the lawn.

In our monumental parks it takes quite a bit of maintenance due to the trimming problem. If you can visualize from 100 to 400 family monuments in one acre of ground with a monument on each plot to trim around, you can see how hard the job is. We can do this now with mechanical equipment. We are able to maintain our parks in a presentable manner so that the public doesn't mind paying for something good. In our memorial parks where we only have the flush grass marker, we have a lesser cost of maintenance. That is what a cemetery is striving for at all times. In a cemetery where we are cramped for space, we must keep in our mind at all times the cost of maintenance.

The development of the memorial park has cut down on maintenance. We used to try to retard the growth of grass because we had to mow the grass once a week. We wanted to mow it once a month. By developing memorial parks where we don't have this problem of trimming, we are able to develop our turf and spend more money for fertilizer. We have heard a lot about aeration. We are able to do that until we start making burials. We have to revert to a fertilizing program after burials start. Up until this time, we haven't caught any grass clippings. We do expect to do that sometime in the near future.

Speaking of cost, we have developed a plan in the cemeteries whereby we set aside money to take care of the cost of maintenance once we run out of something to sell. In the state of Texas a cemetery in order to open up as a perpetual care cemetery must register with the state. At the end of the year we must submit an audit to the state banking commissioner. We must put into the fund at least 10% of the lot sales for the year. In our case we put 25%. We feel that somewhere along the road we will put 50% of each sale into that fund so that in years to come we will have sufficient money to maintain our property.

In the cemetery that I am now operating, there is

enough ground to bury Fort Worth for another 130 years. That sounds like a long time, but actually it isn't a long time when we get to thinking about the light years from the sun or some other method of determining time. Most cemeteries in Fort Worth have an acreage of from 100 acres to 600 acres. However, in the development of the cemetery we will arrive at new methods of burial. We bury above ground, one on top of the other, underground to conserve space and increase the maintenance fund. That is of necessity. When our property runs out, we build above ground niches. In the past 44 years our cemetery has put something like $300,000 into the fund. We feel that as time goes by and we get more financially able, we will put more money in.

Back about five or six years ago we were selling spaces for 40 or 50 dollars. Since developing our turf along with a lot of other things, we have been able to sell spaces for 200 dollars. We give a lot of credit to the development of good turf. Of course, we spend a lot of money on other things too, but we do give credit to good turf from a general appearance standpoint. Understand we still have spaces that we sell for $20.

In our watering problem we have been depending on Mother Nature for the development of our turf and she has done a pretty good job for us as far as our water is concerned since we have been using fertilizer. Up until the time we used fertilizer from the middle of August to the first of October we burned off the grass and they were brown during the hot summer months. Early spring we would have a good crop of clover, milkweed and all sorts of weeds. The first thing we did was try a little weed killer. A weed killer is a good thing but I think a fertilizer program is better. We abandoned a weed killer in 1948 and went out and fertilized. Every year we have been following our fertilizer program in the spring. We usually put on from ten to fifteen tons of fertilizer. It is certainly justified. We cut our grass about two inches above the ground. We feel that that does help us in keeping the turf green throughout the year without a watering program. A water program in our particular location is almost prohibitive. From necessity we have to revert to fertilizer. I believe that most of the fellows here who have seen our park four or five years ago and those who have seen it in the last two years will agree with me that the fertilizer program that we have followed has certainly given us good results.

Slides

This shows one of our areas with a little center feature. Notice the trees. Four years ago we didn't have a blade of grass in there. We did have spotty turf. In some places they had planted St. Augustine and the lot owner came out and watered it regularly. The first thing we did was prune the trees. Then we reverted to a fertilizer program. We have been advised that we should use a little bit of lime and we are going to do that.

That turf here looks pretty good but it is a good crop of nutgrass. We plowed that area up in order to prepare it for sale. We leveled it up and the grass started to grow fast. We mowed it and it looked pretty good. Normally the people don't realize if it is bermuda or nutgrass so we left it go until we sold it. Once we sold it we sprigged it with bermuda and we do have quite a bit of bermuda. It came in after we had sprigged and fertilized.

This is a scene on one of our sections in 1928. It is practically filled with burials. We have been maintaining this big oak tree. The picture was taken in July and a short time after that the grass looked better than it does now. The turf has developed a good cushion. The lawn in this picture was bare just a month or six weeks prior to this picture. We sprigged it, fertilized, watered and got a pretty good stand of grass. I'll grant you that a lot of that is nutgrass but once we get our bermuda good and hardy, we get rid of the nutgrass.

This is a strip of lawn that was opened in 1926. The lawn is really good now. Just three years ago it was sparse. In front of the Administration Building we have St. Augustine practically covering the lawn. This year we hope to get it completely covered. Our reason for not trying St. Augustine over the whole cemetery is because of the extra water necessary for its maintenance. We can afford to water on small areas but not over the entire cemetery.

This is our superintendent's residence and we just recently turfed the lawn with St. Augustine. The vegetation is practically all nutgrass. We filled in by sprigging bermudagrass but the nutgrass always seems to get ahead of the bermuda.

I was talking about the memorials above ground and you can see them in the distance. The area was opened in

1915. About 75% of it is filled with burials, however, we are able to maintain color. This shows a scene from our lawn area. We did have real good turf this past year. This picture was made in July. If you remember we were having plenty of hot weather at that time and this plot had not been watered. This is another shot showing some of our lawn and trimming problems. We have concrete drives and they all must be trimmed. This is just a feature in the middle of a cemetery. This is a scene that we are going to change in the near future. It is the up-right tablet. We are going to get flush tablets. This is the entrance to the memorial park. We try to color it up with different sorts of annuals and perennials.

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CEMETERY TURF MAINTENANCE

Tom Drumm
Restland Memorial Park

Turf Maintenance of a cemetery is one of the most important maintenance jobs that we have. Without turf in a cemetery you really don't have anything. Without protection from mud or blowing sand or dirt, these things would keep our markers covered half of the time. Turf also gives the grass protection from heavy rains and keeps the ground from washing. So it is very important that a cemetery man pay more attention to the turf problems.

Within the last few years we found that we had been putting too much effort to the shrubs and flowers. Actually more beauty is derived from our turf. In finding this particular thing true, we have started a program of fertilizing. Fertilizer is applied during the winter months. In fact we are just getting ready to start now. In our case ammonium nitrate has been recommended to us since it has a high nitrogen content. We put it on at the rate of 150 pounds per acre. We have a very good spreader for this particular type fertilizer. I guess all of you know that if ammonium nitrate gets a little damp, it becomes very lumpy and hard, but this particular spreader grinds it up and puts it out nicely. We pull this spreader with a Gibson tractor. We have about 150 acres of turf. It takes us about a week to cover this 150 acres. It is very important in a cemetery especially where ammonium

nitrate is used and where you have bronze markers to have somebody follow closely behind with a broom to keep them swept off. Last year we didn't know too much about it and went into a fertilizing program with our eyes half shut and we really had a cleaning problem on our hands later on. We did get quite a few complaints, but we managed to get out of it.

In putting this fertilizer on in the winter, the reason we do that is to avoid watering. We would have quite a problem of trying to water 150 acres of turf. We don't have access to city water; ours is from an artificial lake which is spring fed. In a dry summer the spring stops running. So we would have a watering problem. This last summer we had the most beautiful turf we have ever had. However, we had a very good growing season last year. We had rains just as we needed them. Actually, I believe by putting this fertilizer on in the winter and cutting at high levels like we do, we do the grass good.

I might bring in one thing right here about the complaints you might get from a lot owner from crossing a grave. With a good heavy turf in the growing season, it won't show very much. In other words, if the turf is high and good and thick and the mower is run over it, it will come back in place. Of course, if you have a grave filling program going on, it will show and in cases like that we must rake the grave which we do all summer. People are becoming wiser as the years go by. Of course, we are making them wiser by a program of selling. They realize that you must mow, move dirt and all of the other things necessary to keep the place looking neat and trim.

We use a Ford tractor, not for mowing, but for removing excess dirt. People do see us in the cemetery proper with a Ford tractor. We have a black soil and in the dry part of the year we do not track this soil as you would sand. I don't want you to get any wrong ideas about this situation because we do try to avoid getting on a grave. That is something that everybody has a great horror of and that everybody is trying to avoid.

Regarding fertilization of the grave area, we have a walkway between two walks where the families are permitted to plant. When using the spreader in this area it is necessary that we have someone follow behind with a bucket of fertilizer to get the places the spreader couldn't cover. This involves another man but it is really worthwhile.

We cut our grass 1½ inches high. We use a block of wood exactly 1½ inches thick as a gauge. We set it on a level concrete floor and all maintenance men use it religiously. Last year we didn't have the grass cut every which way; it had a smooth cut all over. Competition is keen amongst most of our mower men. When they see the nice job they are doing, they try to outdo each other. We try to give the men all the credit that we can in the mowing operation and also in taking care of the mowers. We have a policy of taking care of the mowers. If a man comes in early in the afternoon in time, he washes his mower, greases it, fills it with gas and gets ready to go for the next morning. He will do it quicker in the afternoon because he wants to go home than he will do in the morning because he is going to go to work and it will take him quite a bit longer.

After we talk about grass and the beauty that it creates, we must realize that it also has a bad habit of growing in places that mars the beauty created in other places. For instance, it grows in our streets. Our streets are all asphalt. Bermudagrass just seems to love that asphalt. It might be good to fix a golf green with asphalt because from the way it grows in our streets, it would really give you a good green. Bermudagrass grows in our concrete walks. I believe it was this fall a year ago in Tulsa that I heard of the TCA compound. I was told you could cut almost a straight line with it with the proper sprayer. We used it last year on the streets and it was very successful. I will vouch for that statement that you can cut a straight line with TCA properly applied. We didn't use TCA in our walks because of killing the plants around it. We did use it on the streets.

We still have a problem with the nutgrass. Mr. King gets all good from nutgrass; we get all bad. We don't have too much nutgrass because it doesn't particularly like black soil. But we do have it brought in with plants that we buy. We have one long bed of tulips planted in the spring and it is almost solid nutgrass. We haven't really tried anything on that particular problem. We have places we would really love to get rid of it but we want to grow something right after we get rid of it.

In the last four years we have eliminated push mowers completely. We just use our power Toro's. We follow behind with a Stanley Trimmer. I am not advertising for these particular products but they are what we use. That has cut our maintenance down quite a bit. A man pushing a mower really uses up time fast. The

Stanley Trimmer is electric. We have our generating plants which are easy to push around. We have a thousand and 1500 watt unit. On the 1500 watt we have two men taking care of our trimming. We have considerable trimming to do. These two men trim continuously. We also have two men for mowing. I think that has reduced our maintenance down wonderfully. This electric generator can be used other places as well. We use our power drills for sawing lumber with it. In the last winter during the storm our building was heated with these units because it is heated with electricity and we didn't have electricity for several days. They didn't give too much power, but were helpful. I don't know whether these things will help you or not, I am just passing them on for what they are worth.

I am looking forward to a season that is dry to see if fertilizing in the winter is really good. I have been told that the grass will stay green much longer. I don't think last year was really a good year to test this. It looks very reasonable that it will help a lot to give a good coverage on the ground. I was talking about the brown turf as compared to green turf and I want to agree with Dr. Grau on that. In the winter months when everything is brown, if you have enough green in the way of shrubs and trees, a little brown grass in the winter will keep you from getting tired of the green grass all summer. It has the same job as it has green as long as it is thick enough. It keeps the people out of the mud and gives protection to the grave. Actually I like brown grass about as well as I do green grass.

We have had more comments about our park in the last two years than we have ever had on it. I believe that has been all due to the fine cooperation of the willingness of the members of the Texas Turf Association to give their free advice. By giving us this advice our problems are becoming less for us in the way of turf maintenance.

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HOW THE SOUTHERN REGIONAL GOLF ASSOCIATION RAISED $18,000 FOR A TURF PROGRAM

Glenn Burton
Coastal Plains Experiment Station
Tifton, Georgia

I hardly know where to begin on my subject. In order to start, I must go back to 1931. I had spent the previous summer out at Lyons, Nebraska, and had collected a lot of data for a Master's thesis. I was all set to get a Master's degree at the University of Nebraska. Dr. Keim called me into his office and started out by telling me of the future in turf. After he had given me a pretty good sales talk along this line he told me that Howard Sprague had a fellowship in New Jersey that was going to pay $90 a month. That was a good bit of money back in those days. He told me to go and take it because I had been working with turf. I had just gotten engaged to a girl who wasn't going to graduate for a few years and I wasn't too keen about the idea of leaving Nebraska. I had hardly even heard of New Jersey before and didn't know Howard Sprague from anybody else. But I had faith in Dr. Keim so I wound up in New Jersey in 1932 and began work with turf research. I worked with turf for 1½ years.

Somebody said something today that is very true. Those who are fortunate enough to work with turf and know the satisfaction of working with it realize it just gets under your skin and you want to work with it. I suspect that love for turf that developed as I worked with Howard Sprague had a lot to do with my getting to work with turf at Tifton.

We will jump several years-- years in which we were trying to develop grass-- primarily to develop pasture and forage grasses and picking out these things that might be turf possibilities because we couldn't get turf out of our blood. The summer of 1946 came along and Dr. Ammodt, my boss, and a guy named Fred Grau came down to Tifton. They had been making a survey of the turf situation in the south. Fred told me he found a lot of problems in the south and didn't know the answers to them. He wanted to know if we would start some turf research at Tifton. I told him we needed money first of all and Fred said that he would get that. It was supposed to be that easy. I also was working for the division of forage crops and diseases

on pasture grasses and I would need their approval. Dr. Ammodt said that it was okay. So we were on our way. Had it not been for that attitude on the part of Dr. Ammodt, I don't suppose we would have any turf research in Tifton.

After we had more or less committed ourselves we needed some place to put our turf project. I had a place in mind right in back of the greenhouse and it was just what we needed. But Fred Bell had that piece of ground and we didn't think he would part with it. But that was what I wanted. About ten days later we had that piece of ground. George King helped me get that. Then we had a very good streak of luck. Dan Hall decided he wanted to come to college and study turf. We weren't in any position to give him a job but we did anyhow. Dan knew a lot about turf, so he started working for us. He did a lot for us in helping us get all the work under way. It was quite a job putting in the turf plots. It wasn't money and yet it was, because we were getting Dan for about 35¢ an hour and Dan was worth a lot more than that.

In 1947 we took in $1160. That was pretty good and paved the way. There was another man who has been very prominent in this picture. I met him first in New Jersey when he was much younger than he is now. I suppose some people call him a commercial man but I swear I have never heard him try to sell a pound of anything. He is a man, who it seems to me, gives more of his time to help people with their turf problems than almost anybody I know. To give you some idea of the sort of help we have had from him, I ate lunch with him this afternoon and he asked me how my supply of Milorganite was. I told him we would probably need a little, and he told me that they would put a ton of it on the next car that goes down. That isn't money and yet it is money because we are not having to buy some of the fertilizer we have to use. In addition to that he has given us a lot of moral support and encouragement and he has had a lot to do with the contributions that have come from the clubs. I guess you all know O. J Noer.

We have set up a turf advisory committee largely the result of Dr. Grau's advice. Some of the members of the committee haven't been worth anything. But T. M. Baumgartner, who we chose as chairman of the committee and who has been more or less the permanent chairman, has done a fine job, not so much in raising money but in making our turf conference successful and that in turn has helped to bring the money in.

These are going to be scattered incidents that have helped to bring in what money we have had so far. I remember a letter I received from Fred in the winter of '47. He wrote and said that he had a date with some prominent people in Atlanta and we were to go down and he wanted me to go down and talk to them about the work that was being done at Tifton. We had lunch with Bobby Jones, Dick Garlington and some other very prominent people. Before we left they more or less agreed to raise $10,000. We never got the $10,000 but did get about 1/3 of it. It all helps and we did have an opportunity to let them know something about what we were doing.

By the spring of 1948 we had enough money so that we could look around for a graduate student. That is where Texas came into the picture. We got one of the Texas boys-- Robinson-- to help us. He has helped us a lot. He has had to go to school in North Carolina, but while he was there he helped us a lot with the program.

In the spring of 1948 another important incident helped us. I had a telephone call one day from Crawford Rainwater at Pensacola, Florida. I didn't know him and he told me he was one of the directors of the Southern Association and was going to a meeting of the Southern and wanted to stop at Tifton and see the turf plots he had heard about. He stopped with one of his friends and we spent a couple of hours running over the plots. When we got through, he acted as if he was quite favorably impressed and he went on to the meeting of the Southern. It wasn't so long after that until we got a letter saying that the board of directors was going to have another meeting at the Biltmore and they wanted me to go and talk to them about what we were trying to do. In June of 1948 Fred and I met and again we ran through a lot of slides and told them about the work that we were doing at Tifton. I went to the Southern Pasture Conference and three or four days later landed back in Tifton. George King asked me if I did any good. I told him I didn't know but I did think we had made some progress. Last year they had given us $400 and they had agreed to raise it to $1000. They said they would try to raise the funds for our program.

One of the men who I will never forget in this whole thing is Colonel Lee Reid from Lexington, Kentucky. He is a real southern man. After we had been working for some time, one Sunday afternoon the telephone rang and Colonel Lee Reid told me he was in Tifton on the

way home and wanted to look over the plots. We spent most of Sunday afternoon looking over the plots. I am sure he has been of help.

One of the first people who has had more to do as far as the funds are concerned and raising this money is a big red-faced chap over in Orangeburg, South Carolina. He is a cotton broker. His name is Mitt Jeffers. If there is anyone who is any more sold on the program that we have at Tifton than Mitt Jeffers, I don't know who it is. It seems to me as near as I can gather wherever he goes he is always talking Tifton and what we are trying to do. It has had its effects. I think most of the $3500 check that they handed us last September at the turf conference at Tifton probably came as a result of the selling efforts of one man-- Mitt Jeffers. Crawford Rainwater has been right in there working with him. They got contributions totaling $3500.

There are some other interesting things that have happened along the way and the big people haven't done all of this. They worked and organized a Turf Association up in Tennessee called the Southern Turf Association. Every year now we have been receiving a check for $100 from Charlie Danner who is the secretary-treasurer. One of the members of that club just gets under my skin to the extent that I just love the guy and can't help it. He is a great big Scotchman and his name is Pete Grandison. Pete has made every one of our turf conferences. He has shown so much friendliness to me.

A couple of years ago I had another telephone call and this time it was from Johnny Cochrain. It was just another man to me. I didn't know him from anybody else. He said he was secretary of the Southeastern PGA. They were having a tournament at Gulf Port and wanted to have an educational program and wanted me to go down and talk to them. They paid my expenses. I went down and we had a nice time. Johnny let me follow him around the course the first day of the tournament and if he hadn't done that, I think he would have won. He came in second. It was a nice experience. I hadn't been back very long before we got a check for $200 from the Southeastern PGA. It is friends like that who are helping to make the thing work.

We have a Master's Tournament at Augusta every year. For two or three years there has been $1000 coming to us from the Masters' Tournament. Luke, who is the greenkeeper over there, had a lot to do with that com-

ing in. I know that Fred and O. J. Noer had had a lot to do with it too. It has certainly helped to carry the program along.

We have seed companies that have given us most of the seed we needed. We are not having to buy very much fertilizer. Tom Mascaro put an Aerifier down there with us on consignment. We got our mowers at cost. That isn't money maybe, but we save the money. It has helped to make the thing go on and carry through. I think our turf conference is also helping to bring in some money. Just how much, I don't know. It has been surprising to me how these fellows will continue to come year after year to this conference at Tifton. This last summer we had 134 men from 15 states present and that made us feel pretty good. It is hard for us to know how we can help someone up in Virginia very much, but they seem to think that they are getting their money's worth.

Two years ago out on the turf plots when we were having our Field Day, a little man somewhere between 65 and 70 came up to me and said he was Mr. Thomas from Charlotte Country Club. I said I was very glad to know him. We had a couple of his grasses since the very beginning of the turf plots and one was looking very nice. We talked a little bit longer and he said that he just wanted to tell me that he was going back to ask the board of directors of his club to send $250 down for the turf research program. I didn't know Mr. Thomas but I wondered how a man as quiet and unassuming as he was would have that much influence with his board of directors. In less than two weeks we had a check from Charlotte Country Club for $250.

There is another man I don't remember anything about except his name. I wish I did. When you have these turf conferences you are so busy with so many people you don't have much time. This happened on the same day. In the middle of the afternoon we were talking about the plots and I had paused for just a moment and this man came up with a check in his hand. He said that his club was a little club and were not able to do anything so far as supporting this program was concerned, but he believed in it. He gave me the check to help me out. It was signed Oscar Carlsted and it was for $10. I wanted to frame that check and wish now that I had.

There have been other people like that who have had something to do with it. We are now preparing the Southern Turf Foundation Bulletin. Crawford Rainwater

of the Southern is doing the printing and sending it out. I think it will help the people who are interested in growing better turf.

There are two or three other little incidents that I would like to mention before I close. Last summer just before the fourth of July we had a telephone call from the chairman of the board of directors of the Chattanooga Country Club. He proceeded to tell me a long story and said that they had a tournament coming up along the latter part of July with a lot of prominent golfers coming in and they wanted their course in good shape. They didn't have any grass on the greens. They wanted me to go up and tell them what was wrong. I had never done that sort of thing and told him that the turf issue was just a side thing. I just couldn't do it. But he wouldn't take no for an answer. He kept on talking and talking and finally I said that the family hadn't had a vacation and it was hot at Tifton. He said it was nice and cool up there. I told him that I wasn't going to let him pay me a cent but if he wanted to pay the expenses of my family and put us up in a nice cool place, I would go up and stay with him. I told him I had a wife and four children-- the other one away at the time-- and there would be six of us. He told me to come anyway. So we went.

I don't know whether any of you have ever seen the Lookout Mountain Hotel but it is a beautiful thing. As we drove over the mountain and went over the last ridge where we could get a full view of the thing, it just reminded me of a castle out of a fairy tale. The kids just gasped and held their breaths. We went up and they treated us royally.

I went down and looked over the golf course and they had plenty of problems. But the main one seemed to be that they were just starving the grass on the greens. They weren't using enough fertilizer. Fortunately they had ½ a ton of ammonia nitrate and they had some equipment for putting on fertilizer in solution. So I suggested that the thing they needed to do was to put on the fertilizer right away. I got out to the course the next morning about 6 o'clock and worked with Woody Kennedy for an hour or two. We had a delightful weekend and started back home. Wednesday I had a telephone call from Chattanooga and I was just sure that something had gone wrong. The chairman was again talking. He said he just wanted to call me and tell me that I had worked a miracle because the greens looked twice as good as they looked four days before. He said that they hadn't paid anything toward our research program

at Tifton but they were mailing a check to Crawford Rainwater for $250. That helped also.

Out at Memphis at the Southern Seedsmen meeting, Don Hastings called me to one side and said that they recommended to the board of directors of the Southern Seedsmen that they send $250 to Tifton for turf research. I didn't expect anything like that. That helped also.

About a month ago one June night rather late the telephone rang. It was another Scotsman on the other end of the line. He said he was John Anderson from Virginia. That didn't mean a thing to me. He said that he had heard a lot about what I was doing and he wanted to come out and look it over. So he came on out and we spent most of the next morning with him. We looked over the turf plots and I found out that John knew Dr. Grau and was one of his best friends and O.J. was one of his very good friends as was Howard Sprague and a lot of other people I knew. He left about noon. When I got back to the office, I found myself hoping that he would mention Glenn Burton as one of his very good friends the next time he saw somebody else.

I suppose we could have raised that money much easier. I am reasonably sure we could have. Somebody could have gone before the legislature. I think it could have been done. I don't think I would have had an opportunity to make nearly the number of friends we have made. I don't think we would have the support for the program that we have. I think we would have missed a lot by doing it that way. I can't and don't have enough faith to believe this can go on forever. I think we need some tax support too. I think that is the way most of it should be taken care of. I think the taxpayers if they just knew about it, more of them would probably support turf research than anyone thing but somehow or another we have avoided selling it to them. It takes a lot of extra time. There is a lot of work in it as you see. But I have come to the conclusion after having lived 40 years that friends are probably worth more than anything else in the world. You don't mind putting in extra time when you have friends who will tell you that the thing you are trying to do is worthwhile and will make you feel that it is really appreciated. I have worked with a lot of groups of people. I have yet to find as much appreciation and people who can say thank you as effectively as the turf people with whom I have worked thus far. It has been a delightful experience and I hope it will continue.

MAINTENANCE OF TURF ON GOLF GREENS

O. J. Noer
Milwaukee Sewerage Commission

I have with me a few of the solutions we are employing for grass tissue testing. If you want to see them, you are welcome to do so at the end of the hour. In making the test grass clippings are gathered, the juice is squeezed on the filter paper and then the test is made. When grass gets enough nitrogen, there will be nitrates present in the tissue. The same is supposed to be true of phosphorus and potash. The white powder for nitrogen produces a red color, the blue color is for the phosphorus and the reddish brown spots are for potash. If we have a pink color for nitrogen, a blue one for phosphorus and a reddish brown for potash we believe the grass is getting enough food from the soil.

Several weeks ago I was at Ponte Vedra in Florida. I knew the ryegrass on the first tee needed nitrogen from the way it looked. The test bore this out. Later I made a test on another tee and got a nice pink color even though the grass appeared to be badly in need of nitrogen. This tee had been fertilized two days before. The nitrogen had been there had been taken up by the mass but had not started to show itself in growth. I was told by letter that three days after I made the test the rye turned green and started to grow. So with those few preliminary remarks let's get on with the pictures.

That is a picture taken at Nashville, Tennessee, at the Richland Course. It shows a pile of sawdust which is being used there as the source of organic matter in the top-dressing mixture. It has been used for several years and as far as I can see the greens are behaving well. It is doing a good job of furnishing the organic matter which is needed, at much less cost than peat.

The next picture is a soil profile from a green in Milwaukee. It shows the original soil and the kind of top-dressing used by each greenkeeper. The sand content is rather high at the bottom. Gardiner was a sand enthusiast. When Haslow took over charge the greens were drying out a little faster than he thought they should so he used a lot of peat. After that had been done for a few years the greens became a little bit too spongy. When Ted Booterbaugh took over, he

built up a medium sandy loam with about 20% organic matter. He used about two parts of sand, one part of a loam soil and one part of humus material. Since he has been doing that the greens have been exceptionally good.

This is an example of something we believe is bad practices. I don't care whether it is bermuda or bent. Probably bermuda will survive under conditions such as this but if there are sand layers imbedded within an inch or two inches of the surface, it complicates maintenance during hot weather at any time of the year. Roots seldom go down through sand layers because of a false water table. When the weather is hot, the surface dries out, the grass begins to wilt and it becomes necessary to put water on constantly in order to keep the areas alive. Soil should be uniform in texture and should be a medium sandy loam.

This is the same green showing tree roots from elm trees. I believe the next picture is an overall picture showing the particular green that the plug and tree roots came from. The location is not particularly bad so far as maintenance is concerned, yet there was trouble in July and August every year because of the sand layer, and because of the tree roots. Now that we have means of cultivating the soil we are not quite as concerned about the sand layer as we once were. Trenching, or the use of a tool such as Jim Haines' root cutter will solve the tree root problem in the green. This is a close-up showing the root pruner that Jim Haines made at Denver and uses at the Denver Country Club. When I was there last summer in July,he cut through roots that were at least 1½ inches in diameter. He does a job to a depth of 18 or 20 inches.

This is a rather poor green of bent. Many inquiries about how to eliminate clover from greens are received. The best way is to grow grass. Here is an example of a green which is badly deficient in nitrogen. Clover is a legume and can use nitrogen from the air. These are some plots at Brynwood in Milwaukee. Notice the clover in the check and the absence of clover in the adjoining plot which gets about 1½ pounds of actual nitrogen per thousand square feet per month.

I throw this on to show that nitrogen level is important. These plots are at Rhode Island. Here is what is termed the low nitrogen level plot. Notice the small patches of clover. The reason the clover is there is because the nitrogen level is a trifle low.

The clover isn't big but it is there. The high nitrogen plot is free of clover.

Here is another way that clover can get started. Brown patch was bad on this particular spot of turf. It thinned the turf and then the bit of clover really started to grow after competition disappeared. Here is an example of clover starting in a spot where iron chlorosis thinned the turf. The grass died and then the clover could make headway.

This picture was taken some years ago at Oklahoma City. This is a patch of bent and I believe that it has been fertilized generously in late fall with urea. Notice how the grass was able to retain its color longer after cold weather set in than the unfertilized plot alongside of it.

This picture was taken in yankee land where people are frugal. I think you can see the vivid green spots on the lawn. Poor growth elsewhere is due to a nitrogen deficiency. Here is the fertilizer factory in the background-- a small female dog. The next picture is on the lawn of my next door neighbor in Milwaukee. The spots are brown instead of green because the dog is a big one. If a little fertilizer is good, it doesn't necessarily mean that a lot is much better.

Here is a fertilizer burn on a green. The fertilizer was put on when there was dew on the grass. Burning occurred even though the green was watered almost immediately afterward. I hardly need tell you that it is important when putting on a soluble fertilizer that the grass be dry and to water it in promptly afterward.

This is one of the plots on the velvet bent series at Rhode Island. Notice the large quantity of crabgrass on this strip and the absence of crabgrass on the other areas. The only difference is that this strip is top-dressed and the others are not. Obviously the crabgrass is being introduced in the top-dressing used on the area.

A couple of years ago I drove from Trenton down to a shore point in New Jersey for a meeting. I stopped and took this picture of the potato field. The soil from the standpoint of physical conditions was wonderful, a fine sandy loam. But just notice that the field is almost solid crabgrass. I am sure if one were to use that soil, he would have a serious crabgrass problem.

This is a green in the Detroit area. The picture was taken in 1949. The golf course was out of play during the war. The greens were mowed once a week during that time. After the course was put back in play they were afraid to be drastic enough with the bent to remove the mat. In 1949 this is what happened. Notice the thick dense heavy mat of partially decayed vegetative material on top. The mat consists of partially decayed stems and leaves and not of roots. With this condition, localized drying is apt to occur because the thick mat sheds water. The thing to do is to hand rake and cut close and to use a comb in front of the power mower and really go after the turf and not worry if it gets brown. This is a green in Milwaukee that gets treatment of this kind every spring. Even though it is bent and is reasonably tight, Les is rough with the turf in order to remove the mat.

At one course in Minneapolis where there was a bad mat they were rather drastic with brushes on the power mower. After that they used this spike disc enough times to tear the turf so top-dressing made contact with the soil below. There is no point in trying to eliminate the mat by top-dressing alone. Unless the top-dressing can make contact with the soil below, you have created a potential source of trouble because the mat is buried where you can't do anything to remove it.

This is an example of iron chlorosis. Last summer I saw a lot of it in Nevada, Utah, Montana and Wyoming. There it is due to a high calcium content in the soil and is called calcium chlorosis by some. A lot of water either from overwatering or from downpouring rains saturates the soil and aggravates chlorosis. Frequently the grass automatically recovers. Other times it does not. This is a green in Cincinnati. I took the picture last September and I presume you would say that was scald or something similar. But I know it was an example of iron chlorosis. We proved it by putting some iron sulfate on one of the other greens after placing an empty bag on a spot so that part of the green didn't get the iron sulfate. Where the iron sulfate was put on, the grass recovered its normal color. This is another example on the same golf course of iron chlorosis. The grass withered and died as a result of a deficiency of iron.

This shows how a bermuda green in Miami was sprayed for iron chlorosis. It is important not to use over $\frac{1}{2}$ to one pound per green with a minimum quantity of water of 20 to 30 gallons of water. Then the material

will stay on the leaf and be absorbed directly into the plant. When the copperas or iron sulfate is washed into the soil, the iron is apt to become fixed and no benefits will be obtained.

Here is a green outside of Louisville. The club was inclined to blame the copper sulfate which was used in the water in the swimming pool. There wasn't enough to cause trouble. Usually we look for some other reason than ourselves when things go wrong. This was due to too heavy a mat and continuous overwatering. Here is another bentgreen in Oklahoma. Weather was dry and the greens were as brown as the dry fairways despite watering. The man on the job thought it was due to too much sodium chloride in the water but actually it was another instance of too much watering. His successor has not lost any grass.

This kind of thing is bad in hot weather. Daytime watering is not dangerous even when temperatures are above 100 and the sun is out provided you don't put on too much water. If the water puddles it will cause trouble. I was rather amused at Atlantic City one day when I was there. There was a pond of water in a low spot on one green. The greenkeeper instructed a workman to push the water off the green. He said that was not necessary because the water would be gone by the next day. The greenkeeper said, "The water or you will be gone in one hour. Take your choice."

This green in the Detroit area should be a bathtub rather than a golf green. The picture was taken after a week of ten days of continuous rain accompanied by hot weather. Nobody can avoid loss of turf under such conditions when the surface drainage is bad. In rebuilding this green it should be constructed so surface water can move off rapidly because runoff is the quickest way to get rid of water. Then good underdrainage is important so absorbed water can be moved away. At West Point even though some of the greens are badly contoured, they have been able to hold turf during hot rainy weather by using the G-L Aerifier immediately. They use it to dry the green. The water goes into the Aerifier holes.

When you have a green that is badly contoured hand watering is about the only way to control soil moisture. The workman can direct the water to the high spots and let surface runoff take care of the low ones. If a green is built well automatic sprinklers can be used because absorption will be more or less uniform over the surface.

This picture was taken in New England. I believe you can see how the grass along this edge is starting to turn blue and brown. The grass is wilting and it is doing that because these nearby banks were not kept moist. When they are permitted to become dry, the dry soil pulls moisture from the edge of the green and wilts the turf as a result. The next picture is on another course to show how they take care of localized drying of banks during drought. These sprinklers are allowed to go all day long. They do not interfere seriously with play.

The damage here is caused by power mowers. It is due to quick turning along the edge instead of a circular turn on the aprons. The friction of the drum bruises and burns the grass. An ugly bare strip results. The next picture is of a green in central Wisconsin. It shows what happens when the greens are small. The bank in back is abrupt so there is no place for the operator to turn except on the putting green. Loss of grass is bound to occur with the present power mowers.

I have been waiting for almost a year to get this picture. The tee for the next hole is just beyond to the left. Every player places the caddy cart on this strip along the edge of the green while he putts out. Then he goes on to the next tee. Those of you who are building a golf course had better take into account caddy carts and see that the tee is placed so players will not come up onto the green or apron with their caddy cart.

This green in Minneapolis is mowed by power. You will notice that there is no loss of grass along the fringe areas. Here you can see the pattern made by the mower as the operator makes a big swing before going back to cut the next strip. An effort is made on the same course to please the golfers. Instead of allowing the apron to stop abruptly alongside the putting green, notice how one or two mower widths of grass is cut a little longer than the putting green proper. It is far better than the abrupt change from long grass to closely slipped putting area on this green. Without doubt the golfer prefers this method of cutting to that on the other green.

This is a picture of common bermuda on a green at Augusta, Georgia. It looks something like the grass that Burton showed. However, part of the trouble is due to a low level of nitrogen. The bermuda is not getting enough nitrogen to keep it vegetative, and the greens are not top-dressed frequently enough to keep

the stems buried. The next picture is one that I took at about the time the war ended. It is on one of the golf courses at Miami Beach which the army took over. It was not played during the war. Notice the different types of bermuda in the green. The green had been in play for 25 years. All the better bermudas stayed vegetative and produced very few seed heads as compared with this one in the background. When Burton mentioned Tifton 57 and its poor seeding habit, it seemed good to me. I believe the better bermudas are not going to be big seed producers. They will stay greener and will be better for play if they stay vegetative and don't produce too much seed.

The next picture is one of a green at LaGorce which is also an old one. Notice the different types of bermuda in the green. Some of them are far better from the players standpoint than others. This picture is one of a bermuda green at Miami Beach. There are 18 like this at one course. This is not the Tifton 57. It is a local strain which they call Gene Tift. Whether it is going to stand up and be the right kind of performer, nobody knows but it is a good grass to putt on even without the rye. The next picture shows a close-up of the texture of this grass on the 18 greens at Indian Creek.

This is a picture of some plots at Jacksonville. I believe this one is bermuda overseeded with rye. The next picture is one of poa trivialis overseeded on bermuda. Many of you with bermuda greens don't treat them rough enough before seeding to rye. Unless seed makes contact with the soil, it will not produce a good stand of rye and the rye will not withstand cold weather near as well as if the rye is deeply rooted. Notice how the rye on this green has come up only in the Aerifier holes.

The next picture is one of a renovator which is not made any more but is used in the south Florida area to renovate bermuda greens in preparing to seed with rye. In that region they are beginning to use more bluegrass, red top and even bent to winter seed.

Here is a mower which I think will perform better on ryegrass greens than some of the other power equipment I have seen injury on rye that I think is due to the power units used.

I showed you the soil profile from one of the greens at Milwaukee Country Club. This is a picture of the No. 18 approach and green. The greens are all in per-

fect condition throughout the year because soil conditions are right and the man who takes care of the turf has the know-how to do a good job.

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BREEDING GRASSES FOR BETTER TURF

Glenn Burton

Coastal Plains Experiment Station
Tifton, Georgia

This morning I would like to give you a little bit of an idea of what a grass breeder has to do when he trys to develop improved grasses and, in this particular case, turf grasses. I think we will start right out with slides.

One of the first things that a plant breeder does is make hybrids in order to bring together characteristics that he is interested in trying to combine. For example, we may have a grass that is drought resistant but isn't disease resistant and we may have another variety that is disease resistant but isn't drought resistant. So we hybridize those two in order to try to get from that combination a grass that is both drought resistant and disease resistant. The technique is pretty much the same for all kinds of plants. For turf grasses it is rather difficult to do because the flower parts are so small. You are looking here at a grass flower. I don't know whether you ever thought of grasses as having flowers or not, but that is a typical grass flower. These two little feather-like things you see here are the stigmas or the receptive parts of the female part of the flower. These three things that you see here are the anthers or the male parts of the grass flower. In order to make hybrids, we must remove these three anthers before they shed pollen and then introduce pollen from some other plant that we want to cross with it onto these stigmas. It is very important that this be done without getting any pollen on the stigmas as we try to do what we call emasculation.

One of the things that makes it so difficult is that this flower isn't as large as it appears here but is the size of a bermudagrass seed-- in the case of bermuda-- which is about the size of a pinhead. We have to use very fine pointed tweezers and a magnifying

glass in order to see them. It is an extremely tedious job but after a good bit of it, we eventually come up with something that looks like this. You can see these little stigmas sticking out. Next we select pollen from the grass we want to cross with it. This process consists of getting the pollen on the stigmas. That pollen grain germinates, sends out a pollen tube which fertilizes the egg and you get a seed. That is your hybrid seed. After we have pollenated, we put it in a bag and label it so that we know what the parentage of that particular cross was.

You fellows will recognize this as the heads and stems and one of the runners of bermudagrass. It is a grass that I think probably is as well adapted to the south as any grass that we now know or ever will know. Certainly it is well adapted to a wide range of conditions. It is a grass that we may not be able to surpass as far as turf for the south is concerned. It is used on football fields, areas where you have a lot of wear and it is very good there. It is one of the most drought resistant grasses and does well almost everywhere on our well drained soils provided we take into consideration the few things that we must consider if we use this grass properly. Very briefly I will point those things out. Bermudagrass will not grow in the shade. It doesn't like wet feet; it has a rather high fertility requirement and we have found that it takes a lot of nitrogen to make good bermudagrass turf. If you put it down, it does make a good sod. Then, of course, you need proper management with frequent mowing to make a good turf.

You are looking here at a Colonial bent green planted at Capital City in Atlanta, Georgia, back in the fall of 1948. This photograph was taken on the first of July. It was a beautiful thing. It looked like he was going to be able to grow bent and he was happy about it. After about a week of hot, muggy weather and although we had put on a regular fungicide schedule at weekly intervals, big brownpatch hit it and this is what happened. It demonstrated pretty well to us that until we get strains of bent that are more resistant to disease and particularly big brownpatch, than those that we now have will give too much trouble to make it practical to use bent on most of our courses over the humid southeast. Now you fellows out here where you don't have the humidity have a different situation and you will be much more apt to be able to use bent successfully.

I told you last night that back in the summer of 1946

Dr. Grau came through with Dr. Ammodt and suggested that we start a turf research project at Tifton. One of the first things we did was to plan a test in which we would evaluate a number of these bermudas that had come out of our bermudagrass pasture breeding program and compare those with the best that we might pick off our golf courses in the south. We sent out a circular to a great many greenkeepers in the south requesting that they send us plugs from the best bermudagrasses on the greens in order that we can include them with the test. They came in and as they came in we planted them in old gallon cans in the greenhouse and we were quite surprised to find the tremendous differences in these bermudas.

This one was the coarsest and biggest of the lot. It came from Florida and it is very difficult to imagine what kind of a green it must have made. I can't understand why any one would have picked that one as being a good green. This one was a by-product of our pasture breeding program. It was a little dwarf that had appeared in some 5000 selections of bermudagrass and for two or three years it didn't make any seed heads at all. It looked to us as if it would make an ideal grass for greens. Those are the extremes of bermuda.

We started breaking them up in the greenhouse in the fall and winter of 1946 and 1947. We planted 32 of those 2-inch clay pots and had them well established. In April, 1947, we went out and marked off a number of plots 8 feet square on which we would attempt to maintain as greens and 12 foot square plots we would try to maintain as fairways. Within each group of nine right in the middle of it we planted bermudagrass from seed. That was our check. It was the thing we had to beat if we were going to have something that was better than most of our people were using on their greens.

This gives you an overall picture of what we had from that April planting in early July, 1947. We have allowed them to grow up. This gives you some idea of some of the variations you get from bermudagrass. They were fertilized exactly the same, were started off with the same kind of planting. This one grew tall and this one hugged the ground.

Now we want to look straight down on some of these bermudas. Again remember that this is in early June. This is bermudagrass from seed. It is common bermuda which is the kind of turf you will get when you buy

commercial bermudagrass seed and plant it. This was one of those bermuda's that didn't spread very much. One of the things we wanted to know as we evaluated these new bermudagrasses was how rapidly they spread and became established. If we are going to have to propogate them vegetatively, rapid establishment is very important as you can readily see. This is another one that came from Pinehurst. It was fertilized and planted exactly the same as the one you just saw. The difference in the rate of spread is what we call genetic differences-- differences in the make-up of the two plants. This is another one that is a by-product of our pasture breeding program that carried the number 57. It was later to become the strain that we now know as Tifton 57.

This is the way those plots looked in late July. We were beginning to mow them down in shape and trying to simulate greens maintenance and we had the plots pretty well established. We decided the only practical way to handle them was to let the grasses grow together. We had another very good reason for doing that. We were interested in finding out how aggressive they were, whether or not they would crowd out other bermudas or whether they would be crowded out. You see, if we were going to try to introduce better bermudas into existing bermuda, it must be able to crowd out existing turf or it will never amount to anything. Let's take a close-up of these in late July. This is our common bermuda from seed. It isn't bad coverage but it is still pretty open. Pinehurst is a beautiful thing. Tifton 57 is about as good as Pinehurst at that particular stage.

In the fall of 1947 we had about ten days of unusually warm muggy weather. When it was all over we had a tremendous amount of helminthosporium leaf spot and we had a chance to take this picture to show you how much disease resistance really means in the humid southeast. This is common bermuda. Leaf spot has turned it brown. This is Tifton 57 which again showed up superior as disease began to enter the picture. Let's take a close-up of some of these. This one is common bermuda. I think you can see that a lot of that grass is dead. We are looking here at another one. This is Pinehurst and you can see that although it was better than common, there is still a lot of disease in it. This is U-3. U-3 is an excellent turf bermuda and it looks very good for us under most conditions, but when disease comes along, it just won't take it. This is Tifton 57. It is still superior.

One of the major problems in the southeast where we are using bermudagrass is the transition of bermuda to rye and back to bermuda if we want to have a green playing surface during the winter time. In order to get at that and see what we might hope to do in the way of solving the problem, we have been overseeding every year on each one of those plots with a strip of ryegrass. We put about 40 pounds of seed per thousand square feet, which is about the average seeding rate of the better greenkeepers in the area. We took notes on what happened as the ryegrass went out and how much of a problem we had to introduce rye into the different bermudas. This photograph was taken on the 8th of March. You have here an opportunity to see the difference in the way certain bermudas come out. This one was making very little growth, but this one was coming out nicely.

This photograph was taken on the 28th of April, 1948. Ryegrass had gone out. This is where the ryegrass had been. This is common bermuda. This is where the rye was. The question came up whether or not ryegrass has an effect on bermuda. I think that it does and particularly if the bermuda is rather weak as it goes into the fall as is common bermuda. Here after the rye went out, we had very little left. This is Tifton 57. The photograph was taken on the same day and it was fertilized exactly the same as the previous one. This is where we had no rye and this is where we had the rye. There was still some evidence that the rye had been in there. The transition was practically nil there.

I want to jump to another year and see what these things looked like on the second of June, 1949. This is common bermuda. You remember earlier in the game we had a pretty good stand, but now it is pretty thin and pretty open. This is Pinehurst. It is still a beautiful piece of turf. This is Tifton 57. It is as good or better than Pinehurst. This is a new one that was creeping into the picture that was requiring a good bit of our consideration. It is much finer than any of the others. It is one that came from East Lake Golf Course in Atlanta. We classify it as an African bermuda. It is very much like velvet bent and makes a very excellent playing surface. There is no question but that it makes a better playing surface than Tifton 57.

We want to look at them on the 29th of September. Common bermuda is a little better stand but there is a lot of dead material and a lot of Egyptian crab com-

ing in. It just won't keep out the weeds. Pinehurst is much better but it still has a good bit of dead material in it. Tifton 57 is king. East Lake which is the thing that looked so beautiful on the second of June, browned out with the hot weather we had in the summer. That has been pretty much the story with most of the African bermudas.

This is a very logical place for the plant breeder to come into the picture and try to combine these strains. We have made a great number of these crosses and some of them look very promising. They are much finer than Tifton 57 and much denser and are ending up much better than the African bermuda. We have a lot of hopes for them. Incidentally, they have come back more rapidly after the frosts and freezes we have had this winter than any other bermuda we have in the tests. They seem to be able to grow at a little lower temperature than the other bermudas which may have quite a lot of significance as we try to push them a little farther south where through their use we may be able to eliminate the use of rye altogether.

We want to look at these again now in the summer of 1950. We have just had a long dry period. We haven't watered them and some of the people who have come by wondered why we have let them go without water for such a long time. We have a reason for that. We wanted to try to find out how they compared as to drought resistance. This is common bermuda. There is not much left. Pinehurst for the first time looked pretty bad. There was a lot of dead grass in it. U-3 is definitely better than Pinehurst. It was one of the first times it had actually been better than Pinehurst. Tifton 57 is still at the top of the pile.

We have taken 35 different sets of notes on these bermudas since 1947. You must look at them a number of years before you have enough information and will know how they will stack up and how they are compared one with the other. This gives you some idea of some of the stuff we are trying to get on these bermudas. We have listed on the left some of the measurements we have taken. We are interested in 2,4-D injury. We found a lot of difference. Some bermudas can stand more 2,4-D than others. We also have a rate of coverage, sod density, head height, fineness, stability, disease resistance, color and a lot of other things we didn't put on there.

Whenever we go over and look at these plots we simply put down a rating which is one (1) if they are very

good and five (5) if they are poor. They fall in between depending on how good or poor they are. Just to go across the board and show you how that thing may work, let's go down here to disease resistance. The bermuda that was established from seed had a rating of 5 as far as disease resistance. It was bad. We had a bermuda that lived in Pennsylvania for a number of years and we thought it would have a lot of promise and it probably does. It had a rating of 5 as far as disease was concerned. Tifton 57 had a rating of 1 on most of the things. It was superior which means that it is easier to maintain for lawns and turf of that type. This is thrown in there just to give you some idea of the paper and pencil work involved with the breeding of grasses.

In the improved varieties of any grass or any plant, it isn't worth a thing until it gets out doing the job that it was designed to do. That means that we must work out methods of producing seed or planting stock; we must work out methods of getting that plant where it belongs or we have wasted all the money we invested in the development of that plant. They are trying to produce seed on Tifton 57 out in Arizona and California. So far that hasn't been successful. As far as I know, that holds true for U-3. They just are not going to produce very much seed. That means vegetative propogation.

One of the things we have been doing in the last few years is to try to find out the best way to introduce Tifton 57 into other bermuda turf. Here we are sprigging into Aerifier holes. That is one way to do it. Another thing we have been trying out is laying a four-inch strip of the sod in a furrow that we cut out in existing turf with a home-made cutter of this type. It cuts out a strip about 2½ inches deep, 4 inches across and you can go pretty fast with it. However, the technique that we like best is to simply put in round plugs. We use a cup cutter. You will notice we are putting a little clamp on the handle so that instead of going down full depth, it only goes down about three inches. We cut out some plugs of Tifton 57 and then cut out plugs on the existing turf. We set them at various distances to try to find out how close we need to plant them and that sort of thing to try to introduce them in this manner. We think this is one of the best ways to try to introduce them into existing turf.

A new development, for which we thank you fellows in the west, is for first trying methyl bromide to con-

trol bermudagrass. We think it will have a lot of value in making it possible for us to make a rapid transition from one type of bermuda to another. That is some of the work that we did last summer. This is where we applied methyl bromide and this is where we didn't. It completely killed out the bermuda. We came and put the grass back in different ways. Where we had already killed out the existing bermuda, sprigging into the Aerifier holes seems to be the more effective and most rapid way of getting establishment.

I said something last night about the turf conference we have at Tifton each year. This is the group we had in 1949. We would have had more in the picture of the 1950 meeting but the shot I had wasn't very good so I didn't bring it along. In connection with that, I would just like to offer any of you an invitation to come to our turf conference next May if you can. We would be very happy to have you and to try to show you in more detail the things that I have tried to show you in a limited way this morning.

This is headquarters. If you drive north and south on Highway 41, you will see this sign. If you happen to be on Highway 41 anytime driving north or going south and see this sign, just remember that back here about ½ a mile is where we hang-out and we would be happy to have you come over and give us a chance to show you some of the things we are trying to do.

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IMPROVEMENT OF FAIRWAYS WITHOUT A WATERING SYSTEM

Howard B. Sprague
Texas Research Foundation

First of all I think I should say that a lot of work on fairways can work pretty well for lawns, parks, athletic fields, cemeteries and similar turf areas that are cut a little higher than fairways. So this topic isn't necessarily limited to the improvement of fairways alone but also to the improvement of all kinds of turf of that type.

Water is certainly essential to growing all plants. My travels through the western half of the United States have brought out one comment that I find almost everywhere and that is that this is a wonderful region. It will grow anything as long as you can get water on it.

In other words, there is a deep seated belief in the west that water is the only thing limiting the growth of plants. I won't deny that we are short of water on occasions. Some places are much shorter than others. I think before we go into a real heavy expense of establishing a water supply and all the equipment for getting that water on the grass area and then provide the budget necessary for labor to put the water on, we should see whether that is the essential thing you need to do or whether there are some other things that should come first. As a matter of fact, let's see whether or not there is a crying need for a water system if these other things are done.

First of all we will have to consider the kind of grass you are dealing with. This group comes from an area that extends from the well watered regions on the east to areas out near El Paso that occasionally have rain. The presence of a suitable grass just can not be neglected. Some of you fellows are trying to maintain turf with a hopelessly outmoded type of vegetation. It is weeds or something like that and what I have to say won't apply if you have the kind of vegetation that just isn't suited to the climate or the region or to the use that you expect to make of it. Let's assume that bermudagrass is present in the regions where we have 25 inches of rainfall or more and we have buffalograss in some areas where we have a little less rainfall. I am assuming that is a factor that you will take care of first of all. If you have the wrong grass, the establishment of a watering system will not provide you with good turf.

What I have to say will center around bermudagrass. I am trying to pick out principles that are more or less applicable to all grasses in the development of this kind. I come next then to soil management and to fertilization. There are a great many regions where lime should be used. I was interested in looking up the figures in the use of lime recently and I find in this account that Texas is using just 1/100 as much lime for all uses in agriculture as they are under similar soil conditions on the Atlantic seaboard. That isn't enough. By and large I know we have a great deal of soil in Texas that is suffering from a lack of lime. That is going to represent a lot of different things.

I want to recount some experiences from a lack of lime. Many years ago I was called into a course where they said the turf was bad and they needed expert assistance. After some delay I did go to see what happened. They had never put any lime on and they had

a mat of undecomposed stems, leaves and roots so thick and so dense that water was being shed very fast. One of the things that was responsible for that sodbound condition was the fact that it was quite acid and while there was enough moisture, it was so acid that decomposition had not occurred and had built up a very heavy mat all over the fairways. With liming and fertilization they gradually broke that down and got back to the normal conditions. They couldn't do it without lime. Not all of Texas is that acid but some of it is and I think we should pay a little bit more attention to lime.

Next we turn to supplies of plant food. Back in '47 Roberts at the Dallas Country Club asked me to come out and look over his fairways. They were all bermuda and I asked him what his fertilization program had been. He told me he was trying to persuade the club to buy some fertilizer. We decided to put on a demonstration. We put on just a nitrogen application on this bermudagrass in strips. We put on 50 pounds of nitrogen. These areas were not going to be watered but could be mowed. To our surprise and pleasure those fertilized spots stayed green all summer without any water and it was very hot and dry that summer. The one that had this tremendous amount of nitrogen was the best. That was quite enlightening and it fitted in with a great deal of experiences we had. It brought to my attention very forcibly that some of this so-called drought damage was not truly drought damage at all. It was a shortage of moisture where they hadn't done any fertilizing mostly because they had no root system. That isn't true on all soils. I have had parallel experiences on the arid regions where we have less than ten inches of rainfall. It is really very remarkable what grass will do with that very limited amount of moisture if there is enough plant food present.

There are several angles on that. We seem to find that the time of application is an important thing with respect to nitrogen. I was trying to figure out just why that might be. This is my theory. If you are putting on nitrogen in hot dry periods and there is never an opportunity to wash that nitrogen down deeply whenever the grass roots use up most of that moisture, they will be short of nitrogen. They may not be showing any deficiency in color but they are not getting the nitrogen they should and are not making the overall development. We have had surprisingly good results from putting as much as 100 pounds of nitrogen on in the previous fall. I theorize that when we put it on

in the fall and the ground is relatively dry, usually we get pretty heavy rains during the winter and we get that nitrogen distributed down in the profile pretty well. The following year the grass roots have access to nitrogen in the whole profile. You see a particular problem that applies to the south more than the north. We have higher temperatures, higher evaporation rates and it makes a great deal more difference in the southern regions to have the nitrogen distributed through the soil profile where you don't have any water. I recommend that you try it out under your conditions and see if you don't get better returns from whatever nitrogen you are able to use.

You also need to get away from another thing and that is if you make that 300 pound application of ammonium nitrate in May or June, it is all available for stimulating plant growth. If you put it on a long time in advance so that it gets distributed through the soil profile, you will get better and more even growth during the season than you get if it's applied in the spring or summer.

There is another angle to this. We have all assumed recently that the primary response from the grass fertilizer will come from the nitrogen. There was plenty of evidence that that was the case. If you put nitrogen on with or without the phosphorus and potash, you couldn't see much benefit where you added it. We wondered why that would be because there is evidence where phosphorus and potash do play a very important part in maintaining good strong grass. Here again I will just have to give you my belief on this matter. There is some experimental evidence to report that phosphorus and potash in a fertilizer that you apply is going to be absorbed by the grass in that soil before it gets down very far. 100 inches of rain will only wash that phosphorus in an inch. The potash will go a little deeper. We think these applications of complete fertilizers that carry phosphorus and potash have failed to show any results of those two elements because it never got down to the place where the grass could use it. In some of our other experiments we have plowed the phosphorus and potash down and we seem to get quite satisfactory benefits from supplementary phosphorus and potash.

I suggest to you that we have been overlooking the possibility of strengthening the grass we are growing by using fertilizers in the way we should use them in order to get real benefits. We should put phosphorus and potash on at the time of the new planting and get

them down in the upper two inches. Remember again that those upper two inches are the most important. Those are the layers that will get so hot and dry during long periods of the growing season that anything in those layers will be relatively useless. We should try to get those materials down. Any machine that will open up the sod so that we could put on phosphorus and potash with the expectation that it will get down to the horizon that will be moist and cool enough for root function will give us a chance to benefit from phosphorus and potash. I think we need to reinvestigate this whole business of whether phosphorus and potash are needed on the basis of putting them down where they have a chance to be of some value. That hasn't been thoroughly proven but we have some evidence. It makes me think it is important and it as certainly worth your while to try them before you spend all your money on a watering system.

I neglected to mention one other item about the nitrogen picture. You have a choice of nitrogen fertilizers-- usually sulfate of ammonia, ammonium nitrate or another form of nitrogen that is used and that is the nitrogen that is tied up in organic form. It may be activated sludge such as Milorganite or some plant products that are high in nitrogen. They are always desirable, as you know, on the greens and watered areas because you can control the amount of nitrogen that becomes available to some extent by watering the supply of nitrogen. That type of nitrogen may come into the picture on fairways if you are going to perforate them to get the phosphorus and potash down. You will get the nitrogen down at the same time and these organic fertilizers may be very useful under those conditions.

On many of these turfed areas there are bare spots. They are a special problem. They are areas where the top soil is very thick or areas that get excessive wear and that really give the turf a mothy appearance. I am not talking about shade areas. That is another problem. I want to talk a little bit about those bare spots that occur in open areas. First of all once you have a bare spot your conditions are very bad during the hot summer weather. If you want to know just how bad they are just take a thermometer out there sometime and put in in a grassy area to a depth of about one inch, press the soil around it and leave it a little while so that you can get a true temperature and then do the same thing over a bare area. I think you will find out from a single comparison of temperatures that the temperatures will be 10° to 50° higher

in the bare spot. You have a very bad temperature situation. Furthermore those bare areas just shed water.

I believe those areas can be corrected. I have seen it done successfully in various ways. The important thing is to put something on that bare area to reduce the temperature and the water runoff and to make sure the water that comes down in rain stays there. That might be done by a combination of aeration and mulching with some pretty well decomposed material or by sodding it. Just because an area is bare we shouldn't conclude that it is hopeless. I assure you that it isn't hopeless and it can be made to support a solid cover of grass even if you didn't have a thing growing before. What is needed is to study the reason why that area was bare in the first place.

It has been shown very conclusively that with all species of grass the extent of the root system has some definite relation to the type of mowing. Some grasses will tolerate close mowing better than others. But all grass will have much more extensive root systems if they are not cut too close. That is a general principle that applies to all members of the grass family. However, I have to hedge on cutting too close. With bermudagrass I think it will survive under very close mowing and we tend to get away with very bad practices in mowing. Up north we have set 1½ inches as the very shortest we could mow the bluegrass and still have a good root system. Bermudagrass could be mowed closer, at about 1 inch. We have cut our grasses too close. Before we go to a great expense of getting a watering system, let's see what we can do with that root system by just slacking up on the height of cut. In this question of maintaining grass without a water system, we must think in terms of extending our root system downward as much as possible so that we can utilize moisture and nutrients in that entire soil horizon and not just confine utilization in a very limited zone near the surface.

I am not going to have much time for these other topics so I will just close with two items. One is there are many new grasses coming into the picture. We may be able to go a long way by introducing new grasses and I think all of us should be willing to try out on a small area these new grasses to see whether you have the best one for your area. It may be that you want to try out one of these new grasses such as Zoysia or deeper rooted bermudagrass. I think to get the information quick, you must try it out under your own con-

ditions, give it a fair chance and see if you have a grass that is really suited to your conditions. You might be thinking in terms of a watering system when you should be thinking in terms of a new grass in the first place.

The other item I would like to leave you with is while water is absolutely indispensible for growing all plants, it will never substitute for these other factors that the grass must have in order to grow. We must consider water in its proper relation to all phases of plant growth as one of many factors needed and not as a substitute for all of these others. Before we spend so much money in putting in a watering system, let's see if we can't accomplish what we want to with very much less money by proper attention to what the grass really needs.

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USE AND MISUSE OF WATER

F. V. Grau, Director
USGA Green Section

My job this morning is rather easy because so much of what you need to know about water nas been said. Many of the things that Sprague said and a lot of the things that Burton said I might have said. They all tie together.

At Boston a year ago Professor Musser talked on the use and misuse of water-- the identical talk I am scheduled to give to you. That was published in the March-April issue of the Greenkeepers' Reporter. Another man who knows a lot about this subject is Jimmy Watson because he worked on that problem on our fellowship at Penn State under Professor Musser's direction. Many of the figures that are quoted in Musser's article are taken directly from Watson's thesis. So you see you have the man who knows this subject right here in your midst and I don't think you are utilizing him fully as yet.

The other thing that I want to point out is that these proceedings of the turf conferences that are transcribed and published by the West Point Lawn Products people are full of information on this subject. The one from the 19th annual Turf Conference at Penn State

is full of several articles on the use and misuse of water. There is a great deal of educational work to be done and a lot of that lies in your seeking the information where it is already available.

Not enough of you are getting the Greenkeepers' Reporter that carries so much information. We have with us application blanks for USGA Membership for Green Section subscriptions and applications for the USGA Journal that carries a lot of this information. Nobody is here from Golfdom but we will all plug for Golfdom as one of the mediums of turf information. All three are indispensible to anyone interested in better turf and especially the subject of water relationships. Already a large part of my talk has been concerned with telling you not about the use and misuse of water but about the sources of information that are available to you. I think that is just as important.

One of the secrets of the use and misuse of water is not to put more water on a given soil than the soil can absorb. If you put the water on faster than the soil can absorb it, you are wasting water, you are wasting time and money and you are doing the soil considerable harm. You are also harming the turf. The same thing is true for knowing the infiltration rate of the particular soil with which you are working. I believe that in the construction of the new course here on the campus, Watson and Potts and others made intimate studies of the percolation and infiltration rates of what they determined a perfect mixture of soil. I don't know whether they were perfectly mixed or not, but that is one way to get at it. Jimmy Watson can quickly determine how fast water can be absorbed into any given soil. He was responsible for working out some of the ways in which soil compaction can be determined by X-ray methods. It is a really outstanding achievement and contribution to the scientific and practical fields.

There are many factors that I could quote to you. If I tell them to you, you would not remember them. I might be misquoting. I just want to say that in a number of experiments the figures have been published when you put water on a given soil twice as fast as the soil can take it, you get only $\frac{1}{2}$ as much water into the soil. Isn't that silly? You put it on twice as fast as it can take it, you get into the soil only half as much as if you put it on half as fast. Probably you are thoroughly confused now. In every case--and we have dope on this for the past thirty years--

wherever more water is applied than is needed, the permanent grasses suffer and weeds take the place of the permanent grasses. Many of the weed problems on many of the turf areas that I have seen have been associated with the use of more water than is needed or with water improperly applied. I have never known of any one thing to be so universally true. I am being rather critical and I have to be to put my point across. Every place in the country that I have been to has had more misuse of water than it has had proper use. Howard Sprague just gave you some of the reasons for that -- nutrient levels, improper selection of grass, not using enough lime where lime is needed, etc.

One of the men who is performing a real service on this subject is Dr. Alderfer at Pennsylvania State College. He is working on bentgrass and bluegrass but the principles that he discovers are just as applicable to bermudagrass and carpetgrass as to bent and bluegrass. You may think that the work that others are doing in remote sections of the country don't have any application to your conditions. They do; they have a direct application if we are smart enough to be able to interpret the results in terms of our conditions. Recently another man has become intensely interested in the use and misuse of water on turf and he is Dr. Robert Hagan of the Division of Irrigation of the University of California at Davis. I am going to show you a picture of him a little later. He has done an outstanding job of analyzing and surveying the present situation of existing knowledge concerning the use of water on turf. There is quite a bit already known but it also shows us some of the things we need to know and need to work on.

A lot of things you need to know right now is about what you are doing wrong. I think in the past five years we have had more progress in the direction of the better use of water than we have had for the 25 years before that primarily because we have recognized the fact that soil compaction has defeated our efforts to water turf properly. I am so wrapped up in this subject of the use and misuse of water that I could go on for hours. By the simple process of aerating and cultivating our soils under turf, we are able, without changing anything else, to get better utilization of the fertilizers that we use and to use much less water than we have been using and still end up with better turf.

One of the most outstanding examples of people who are

using less water to grow bent turf on putting greens are the people at the Minneapolis Golf Club where the USGA Amateur Championship was played last summer. I was sitting on the 11th green with Byron Nelson and his wife and we were talking about this same situation. It had been very dry. Everything was burned to a crisp. The fairways had been watered but rather spotty becausee they had not been aerified in any way. I had insisted that the greens be aerified several times prior to that championship because they were overwatering and yet the grass was going out. They aerified and cut down on the watering. They had greens like they never had before. After three days without a drop of water during the Tournament, I asked Byron what he thought of them. He said that the drier they got, the better they played. Those balls coming onto the green were playing into a dry air cushion, not into a soggy, wet soil and turf. They were coming in there and biting and holding because of the air cushion that had developed in those greens. The roots had been extended way down to where they had never been before and were utilizing nutrients and moisture that they had never been able to reach before. The surface was dry. Those greens didn't footprint in the least because the turf was firm and healthy. That was outstanding. A letter from the president of the Club appeared in the USGA Journal recently commenting on the fact of how well they got along during the Tournament with so little water.

I have seen the same thing happen in Denver on bluegrass fairways. They thought they had to water them every week. They finally learned that, even on their nice, sandy loam soils, aeration helped and they were able to water those fairways once every two weeks and have them in better condition for play. There was less interruption of play, less criticism from the players and the water cost was cut nearly in half. Now with the use of Merion bluegrass, which is being used at Denver to replace the common bluegrass, the turf will stay green during the drought when common bluegrass is all burned up. Again the deeper roots of a healthier, sturdier grass are able to utilize more of the water in the deeper horizons of the soil.

I think this would be a good time to run the slides. At the Northern California Turf Conference at Berkeley last May, Dr. Hans Jenny, an internationally famous soil scientist, showed this chart at the turf conference. This is what the structure of a good normal soil looks like. Each little brick or building block in there is a soil particle-- sand, silt or clay. This

is simply to show you what happens to soils that are badly managed from the standpoint of water. These are air spaces. Air is extremely essential in the soil so that plant roots can take up water. In the absence of air a plant root can not take up water and it wilts even though the roots are bathed in water. That is something that a lot of you are going to have trouble understanding until you have seen it work. These pore spaces should be filled with air and water. When they are filled with water and you run mowers and equipment over it, the excess water in the soil lubricates the soil particles and they begin to slip and slide around and it isn't too long before they arrange themselves in this plate-like fashion and you have a puddled impervious soil. You can't get water into it and you can't get air into it. The roots cannot live down in the lower regions where there is no air, so they come to the surface and grow in top. Out in west Texas on some of that turf, you can take hold of the turf and lift it out of the soil because the roots aren't anchored to the soil. We find that condition even today after all of the educational work that has been done by our experts in turf for the last thirty years.

Here follows a series of Koda slides depicting drainage conditions on courses in various parts of the country.

Here the drain tile is essential. There have been some outstanding examples of golf course drainage. One of the more recent that was reported was reported in Golfdom. Bob Williams from Beverly in Chicago put in a drainage system at that golf course and the results have been miraculous.

This is a putting green in Washington where the architect left a hollow in the green. There was no surface drainage. It is a very excellent way to misuse water--leave a hollow in the green so that you have no surface drainage. Then eventually the turf dies and you have to take it up and regrade to let this surface water off the greens area.

This is at Rutgers. They brought in a particular type of soil-- a sandy loam soil that has never been known to puddle. That is excellent drainage and aeration characteristics. That is the thing we are seeking all the way through to get better use of water. Consequently, you don't have the normal drainage that occurs.

This is surface drainage on a green in Minneapolis. I

was up there last fall and this particular putting green of bent has had no top dressing in 15 years. The surface drainage is excellent. The sub-drainage is excellent. Everything is excellent including the turf.

This is #12 at St. Louis Country Club where the Open Championship was held a few years ago. The surface drainage is so good that it is almost exceptional. You can see the slope down from the back to the front of the green. That is one of the things that makes good turf.

The Merion Golf Club where the Open Championship was held last year when Ben Hogan won. This is the 13th hole. It is a short hole and the surface drainage characteristics are excellent as they are on every green on that famous golf course. It is one of the greatest on which the Open has ever been played. The 18th green and the practice green at Merion. It is a little off color but it putts absolutely perfect. The greens are cut at 3/16 of an inch every day and they had rather heavy applications of fungicide to protect them against any emergency during the Tournament. Of course, the color isn't as bright as it might have been. We have learned that you don't play golf on color. You play it on turf.

This is excess water, lack of drainage, puddled surfaces in the Cleveland area on a fairway. It certainly illustrated what has happened in that particular instance.

This is an attempt to correct a bad condition that was caused by the misuse of water. Puddled soil, lack of air, dead grass, algae and now without correcting it, he is just setting more grass in there and that grass is going to die also. It is a rotten unplayable condition from my standpoint.

Even here in the arid regions drainage has paid off because at times you get more water than you know what to do with. Then drainage pays off. The thing may not occur more than once in 10, 15 or 25 years but when it comes, you would rather have drainage than have a loss of turf. This is the Belvoir Club in the Washington area.

This is the preparation of the seedbed. That holds for any kind of turf anywhere. This is on a green at Lancaster Country Club in Pennsylvania. Today we prefer mixing of all of our materials, hauling them in and dumping a uniform mixture of soil on a perfectly

drained base and you have perfect results. We are discouraging the use of Rototillers or any other kind of mixing equipment on the putting green site because I have yet to see a putting green that has been properly built where the materials have been mixed on the site with a Rototiller.

Here is a course in New Jersey. Only by constant, diligent effort was he able to keep grass on this green. It is a beautiful five inch layer of the most beautiful top soil you ever want to see but there is a two inch layer of clay and beyond that is 50 feet of pure sand. It would have drained perfectly if it had not been for that two inch layer of clay to stop the movement of water.

This again is a bermudagrass in Texas. It was taken on that trip that Noer, Ferguson and I took around with Texas Toro and shot a lot of these pictures. It is alternate layers of blow sand and dairy loam and some sludge and they wonder why even common bermuda doesn't grow well.

I am going to disagree just a little bit with Howard Sprague on the depth of root system with the height of cut. It may not be disagreement but simply a confirmation of what he has said. I'll let you be the judge. This is a putting green in Pittsburgh. It is cut at 3/16 of an inch every day. This has roots 12 inches deep. Notice that it is a uniform soil profile and the roots broke off at the bottom. How much deeper they went, I can't tell you but they were broken down here at the bottom. I have found only two or three other greens like that in the United States. People usually look at me and think I'm slightly balmy when I tell them they can have 12 inches of roots on bent putting greens cut at that height. I want to give you a few figures. Those roots at a depth of 12 inches are able to utilize nearly 16,000 acres of land in a single putting green. The soil particles in a 5000 square foot putting green stretched out and laid on a sheet cover 16,000 acres even in Texas terminology. But when those roots are confined to the top inch or two, they can utilize only a few hundred acres and that is why they suffer from malnutrition and drought and everything else.

In California one greenkeeper -- Luigi Galletia- at Claremont at Oakland in his 42 years of greenkeeping developed 7 inches of beautiful top soil on top of a heavy clay base simply by top dressing and it is not

layered any place along the line. That is one of the most beautiful examples of building up a uniform soil profile from top-dressing that I have ever seen. Contrast that with the picture I showed you a little while ago of the bermudagrass green with those layers. This is what we are striving for-- uniformity of the soil profile.

Here is Dewey Longworth the pro, Tom Mascaro and Bob Hagan who has taken up the study of the use of water on turf in California. What he discovers out there will be applicable here. Being a part of this national turf program you will derive benefits from everything that is done every year in every part of the country but you will have to avail yourselves of the available publications to use that information.

At the Riviera Club in Los Angeles they are looking down the 10th fairway. The Open Championship was held here not too long ago. Here is Bob Greenfield from Wilshire Country Club.

That is Charles Hallowell, a County Agent from Philadelphia who was invited to Southern California to help them out with their turf problems. Some of you have been criticizing the film that was shown last night because we mentioned that you consult your county agent. Gentlemen, this is a County Agent with national reputation for developing better turf. If all of your County Agents aren't up as far along the line as he, don't blame them but blame yourselves. You probably haven't given him the support he deserves.

E. W. Van Gorder at the Stanford University Golf Course has done one of the outstanding jobs of proper use of water on his golf course that I have ever seen. It is absolutely remarkable. It is in that arid region where water is absolutely essential, yet it is just remarkable what he has done by watching the water and using it properly. His water men are the most important men on the golf course. He supervises them very carefully. We found no evidence of overwatering of turf on that golf course and that is unusual.

Here is Jack Harper at Penn State on the plots that Jimmy worked on for three years. We sponsored that fellowship out of the subscription funds which come from industry over the United States. That money goes into these research fellowships and when Jimmy Watson finished, everybody said to keep it going because it was so essential to turf in the United States. So Jack Harper is continuing those studies to find out

what happens when you use too much water and how we can correct it. Here they are putting compaction on those plots to find out what happens with compaction and lack of aeration. It is a wonderful study.

For the grass seed production in Oregon or any place else, cultivation is an absolute necessity. They can not maintain yields of creeping red fescue unless they have cultivation. But until recently we weren't able to accomplish that. Today we can do it. It is absolutely feasible and the only reason why some of you aren't doing it is because you are afraid your greens chairman, who doesn't know anything about it, will tell you that you can't tear up the golf course. Yet, that is part of our educational job to show how our specialized areas of turf can be cultivated without being detrimental to the use of the area.

This picture was taken in Texas only five years ago showing the crude implements that some of you were trying to aerate the soil with. Solid tines made out of some discarded oil well equipment that were actually doing more damage than good because those solid tines would be compacting the soil as they were entering the soil. Actually they were preventing the movement of air and movement of the soil because it glazed the sides of those holes. Yet until recently that was the only thing you had to work with.

This is what bent turf looks like when it has been aerated with the Terferator-- the one that drills the holes. In this case the soil was a little wet and each hole has a little doughnut around it. It was smashed and flattened out. It has done a lot of good and some of you are now using the Terferator.

Here is a home-made machine up in Portland, Oregon. Everything is trying to create better use of water and better air relationships in the soil.. The home-made machine worked quite well. In this case they had about a three-inch mat which was like a felt hat. The water couldn't get into it. They had to do something to get the water in. It was one of the worst cases of overwatered bent turf I have ever seen.

This is a home-made machine that was used at the Minneapolis Country Club. It takes out little plugs spaced at two inch intervals. It certainly helped. It may take a cubic yard out of the green. Here he is taking the plugs away.

At Cincinnati at the Field Day a number of machines

were demonstrated including the Terferator, the Night Crawler and the Aerifier. It was quite interesting. The three machines were operated side by side on a putting green and we had a chance to observe what happened several weeks later. This is another type of machine that you saw at the show in Chicago. It is the Soil-Aire. It is a tubular tine proposition.

This is the G-L Aerifier. This is Joe Valentine on the championship greens at Merion Golf Club. He was aerifying within four weeks of the Open Championship. That is unheard of. Those greens were absolutely perfect. The general membership play continued while he was doing it. In about an hour or a little less by whipping the stuff in, dragging and rolling and mowing the members went right on playing and there was not a single complaint registered. These are championship greens. This shows the close-up of the G-L. I don't have to go into that because most of you know about it.

I do want to say that the difference in the strains of grass have a lot to do with the use and misuse of water and the use of different types of equipment. This is a slow-growing bent. It might be a disease susceptible bermuda for all we know. The Aerifier holes didn't heal because the grass couldn't grow. It just wasn't that kind of grass that did any growing. This is a vigorous, healthy creeping bent that healed in a few days. Yet after several weeks this particular bent still had the holes.

This is a block of sod taken from a green in Fairfax and these are the roots sticking out of the Aerifier holes when he took that sod up and regraded the green. You can see what I am talking about. It is miraculous. This was taken in Texas showing the effect of air on the growth of roots on the bent greens. Here again is another example of the growth of roots in the Aerifier holes on bent greens in Texas. The same thing can be shown with bermuda or anything else.

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CONTROL OF TURF INSECTS

H. G. Johnson
Department of Entomology

I am happy to have the chance to appear before this group and discuss insect pests particularly from the standpoint of lawns, golf courses and various other improved turfs of that type. I don't know of any particular group of insect pests that are more difficult to discuss from an organized or logical standpoint because most of the insects attacking turf are rather indiscriminate feeders that are likely to be found not only on improved turf areas but also on waste lands and many other places of that kind which more or less complicate the picture so far as routine is concerned. This group of insects being rather indiscriminate feeders as they are find excellent conditions for feeding and developing when they get onto turf areas that have been highly fertilized, heavily watered and other things are taken care of. Insects are more or less like any other animal so far as a selection of a feeding place is concerned. The more luxuriant the growth and the better the area is taken care of, the more likely you are to have favorable conditions for the development of most of our insect pests. It is not true in all places but it is true almost invariably so far as insects attacking turf are concerned.

This particular group of insects cannot be defined because of the fact that they do develop in other areas other than on turf areas. For that reason the control will vary considerably with the type of area in which the insect is found and the amount of money you can afford to spend on the control of that particular insect. The cost for controlling any of these pests would be prohibitive for pasture greas. You will find the same group of insects attacking turf on range lands, on improved pastures and in those cases the cost of the control will not be justified. Of course, we can afford to go to considerable more expense for controlling these same insects on our lawns at home, on golf courses, on park areas and various other improved places of that kind.

To begin with I think we might readily divide the major insects attacking turf into two principal groups. First are those insects that feed on the surface of the ground, that is on the leaves or foliage of the grasses; and second are the subterranean or soil in-

habiting group of insects which feed largely if not entirely on the roots and underground stems of the plant. The habits of these insects are quite different and naturally the control is different in the two groups. To begin with I would like to take the surface feeding group which will be more common to you and are better known so far as their habits and methods of growth are concerned.

The first is a little group which I will not attempt to identify or discuss here as individual species but a rather general group of cutworm and armyworms. These are the immature stages of moths. This particular group of cutworms and armyworms are going to include at least a dozen species that are widely distributed throughout the United States as a whole. They are nocturnal in habits and hide away during the daytime and come out to feed only at night. Some of them are daytime feeders but the majority feed only at night. The cutworms include some species that live primarily in the soil and feed only in the ground level although there are some other species that feed on the stems and leaves of the plant much as do the armyworms.

So far as control of this group is concerned, it is rather uniform and I might say that within the last few years we have had quite a development in the use of new insecticides and materials for controlling more of these insects attacking turf. So far as the cutworms are concerned, we have two or three excellent materials for controlling any one or all of the members of this species. Three new materials that have been developed within the last four or five years are doing an excellent job. The first of these is Toxaphene which can be used either as a dust or spray. I might say so far as the control for this group of insects is concerned, the dust will probably be much more convenient to use than is the spray. Toxaphene is commonly used for cutworms and armyworms at the 10% dust concentrates and should be used at approximately 20 to 25 pounds per acre. On lawns or park areas particularly areas that are visited frequently by children, after the dust has been applied, it should be washed into the soil with a hose. That would be particularly true for the cutworms and even for the armyworms. It will do an excellent job of controlling. DDT and Chlordane are two other materials that are excellent controllers for all of this group of armyworms and cutworms. DDT and Chlordane are best used as a 5% concentrate and applied at about the same dosage of 20 to 25 pounds per acre.

A second group of larvae or caterpillars are somewhat similar in its appearance to the armyworm group and is the so-called sod webworm. This group again includes several species. Here in Texas we have no less than three or four species of sod webworm which are commonly found on grasses or turf areas almost anywhere. They are not so consistent in their appearance perhaps as the cutworm-armyworm group but very commonly during the early spring months of April and May we have a lot of trouble from these various species of sod webworm. Sod webworm differs from the type previously discussed in that they live altogether within silken tunnels. These silken tunnels are spun on the surface of the ground around and among the stems and root crowns of the grass. These larvae also spend most of the time within this silken tunnel except when they come out to feed. They do leave the tunnel and come onto the stems and leaves of the grass to feed. For that reason they are somewhat more difficult to control than are the cutworms and armyworms. However, two of the same materials are doing a very good job for their control. 5% DDT or Chlordane applied at the rate of 20 to 25 pounds per acre as a dust will do a very good job of controlling sod webworm. In most cases a single application is sufficient although in some cases a repeat application may be necessary particularly if large areas of sod land and turf are around. In other words they continue to move in from outside.

A third group quite different from the two groups just discussed are leaf hoppers and chinch bugs. These two groups are very active insects and somewhat different so it will be necessary to separate them. The leaf hopper will vary in color. Here again it includes quite a number of species that are found attacking turf almost every season. These insects suck sap from the stems or leaves of the plant rather than feed or chew on them as do the groups just mentioned. These leaf hoppers breed rather rapidly during the early part of the season starting in February or March and continuing very abundantly on up until June or early July. These insects very often cause considerable damage to plants by simply sucking the stems and leaves of the plant and then the turf browns and dies. The chinch bug feeds in a very similar manner although the bug starts much later in the season usually about the time the leaf hopper begins to go out. The chinch bug occurs principally during hot dry periods rather than during the early spring. However, their feeding habits are almost identically the same. They suck the sap from the stems and leaves of the plants causing them to dry up, turn brown and eventually they will

kill the plant. These two groups may be controlled in exactly the same way as the sod webworm and with the same materials. In other words, 5% DDT or 5% Chlordane dust applied to the plants on the surface of the ground will do an excellent job for controlling either of these two pests. In the case of the chinch bug it is somewhat harder to kill and two or more applications may be necessary depending on weather conditions. During hot dry weather they are quite persistent and also are likely to move in from considerable distances from turf in other areas.

Another group that is quite common and quite wide spread are the grasshoppers. Here again we have quite a large number of species of grasshoppers that are quite common on turf as well as on many other plants. Grasshoppers are easy to control at the present time with either of two materials. One is Toxaphene and the other is Chlordane both used at 10% strength. During the early part of the season when grasshoppers are small, they can be controlled quite readily with about 15 pounds of either 10% Toxaphene or 10% Chlordane dust. Later in the season when the grasshoppers are practically mature particularly after they have developed wings and begun to move readily from one area to another, considerably larger doses will be required. During that period no less than 20 to 25 pounds of either of these two materials will be required to give you control for grasshoppers.

The last of this group of surface feeding insects that I expect to mention here is another rather large and extremely variable group and a group that is wide spread everywhere on turf areas. These are the ants. Ants are probably more troublesome on turf areas than any one of the other groups that I have mentioned before. Ants are present everywhere in greater or less numbers and can be a very definite nuisance on turf areas where a good turf is desired and where a smooth surface is desired. The more injurious and the more troublesome of the ants throughout the southwest is a group of two or three species commonly spoken of as the agriculture ants or harvester ants. You are all familiar with them, I'm sure. They are great large ants, reddish-brown in color that build up a considerable mound on turf in lawn areas. They not only are troublesome from the standpoint of causing irregular surfaces by building up their mounds above the surface of the soil, but they will also cause trouble in view of the fact that they have a habit of clearing off all of the vegetation for a considerable distance around the mounds. Other species much smaller than the agri-

cultural ant may be equally troublesome in some cases and particularly on lawns where during dry weather they are likely to go into the home where they are a nuisance.

These ants are now readily controlled. In previous years we have had considerable difficulty in getting a satisfactory control not only for the harvester or agricultural ants but for the other species of ants that are so troublesome in the home. Chlordane has proven to be an outstanding material for controlling ants of any kind. It can be used very easily and very simply for the control of the harvester as well as the smaller species of ants particularly if the nest can be located. Where a nest can be located, it can be eradicated by using a 10% Chlordane dust simply dusted in a circle around the entrance to the nest. So far as the larger ants are concerned, simply dust 10% Chlordane dust for a distance of about 10 to 12 inches in diameter around the opening of the nest. This can easily be done with any kind of dusting equipment. If rains occur immediately after this application of dust your treatment may not completely eradicate the ants. In some cases where the nest is very large, one application may not give complete eradication but it will certainly knock them out for a period of 6 to 8 months and sometimes even 12 months. It is always necessary with those larger ants and old nests to watch it during the next 12 to 18 months and re-treat if necessary.

For the other species of ants that make very tiny little mounds, we just use a very small amount of dust thrown into the entrance of the nest or dusted around the entrance of the nest. That is all that is necessary to knock out the smaller species of ants. Chlordane is very effective on all species of ants regardless of where they are found if you can locate the nest and get to it.

Now with regard to the subterranean species of insects attacking turf, it is not so simple in all cases to get effective control although some of these new materials that we have been discussing for other turf insects are much more effective than any material that we have had previously. There are at least three groups of insects. The first of these groups are the so-called white grubs. These insects breed altogether in turf areas. They are the grub or larval stages of a group of beetles commonly known as May beetles or June bugs. These are very large reddish-brown beetles that are very common in late spring or summer. They

are readily attracted to lights at night. The immature stages live altogether in the ground. Some of them live for as long as three years. The species here in the South only in rare cases require as long as three years to complete their life cycle. Some of the species that complete their life cycle in one year in the southern states require two to three years to complete the same life cycle in the middle west or northern states. So you can see that there is a considerable amount of variation in the length of the cycle depending on the locality where these white grubs are found.

They feed in the soil during this period of one to three years. During most of the first year they feed largely on decaying organic matter. During that period they are not particularly injurious. However, in the second and third years they feed altogether on the roots of the grasses or grass crops. So this particular group of insects can be extremely destructive to turf areas. In fact I have seen lawn areas in which these white grubs were very abundant where the root system had been completely cut away 1½ to 2 inches below the surface of the soil and the turf could simply be rolled back like a carpet. In that case the grass is completely killed and the turf permanently destroyed in those areas where the infestation is heavy. The control for this group is much the same as the control for the other two groups so I think I'll discuss the other two first and then give you the control for the three groups together.

The second group contains perhaps 25 or 30 different species in the south commonly known as wire worms. These worms live beneath the surface of the soil altogether. They are also the larval stages of beetles known as click beetles. I am sure you are all familiar with some of the species of click beetles. They are jointed behind the head and when they are disturbed, they have a habit of clicking the head so as to throw them into the air. The larvae are long, slender, very hard and shiny worms that look very much like a new piece of copper wire. They are a copper color. The life cycle of these worms is often very long. It varies from one year to as many as nine years to complete the cycle in some of the middle and northwestern sections of the United States. This group of larvae live for quite a long period of time. They feed altogether on the roots of grass and grass crops. Having as they do such a long feeding period in the larval stages, they do cause a lot of damage to turf as well as to other grasses of one kind or other. It is quite an injurious group of insects that live altogether be-

neath the soil and as a result are not too easy to control.

The third group that I will mention as soil inhabiting insects are limited altogether to the southwestern states and principally to the arid and semi-arid regions of the southwest. This is a pest commonly known as the desert termite. It is very seldom that we find termites in turf areas. Only one species so far as I know can do any damage to turf. It is a common species throughout this area and sometimes does considerable damage. It is very similar in appearance to the wood termite but rather than living in wood, it lives in the soil primarily feeding on the decaying organic matter found in turf areas. The damage that they do is not caused by the feeding habits but a habit that they have following rain during mid and late summer and early fall. They build tunnels up over the turf grass, weeds or vegetation of almost any kind in the area in which they live in the soil. They completely cover grass stems with these mud tunnels and the shading effect causes the death of the plants. You will very often find considerable areas of grass completely plastered over with these mud tunnels after a summer rain. The damage of the termites may sometimes be rather extensive. It is also quite a pest of range lands but perhaps the damage is not so great as if it were on improved turf.

Now these three groups make up the major pests that we find through this area so far as the underground or soil inhabiting forms that are likely to attack the grass. The control for these is simply a question of incorporating some insecticide into the surface of the soil to kill these grubs or larvae as they enter the soil. Two materials particularly have proven to be quite valuable. So far as the white grub group is concerned, lead arsenate has for many years been a recommended control for them on turf areas. However, the two new materials-- DDT and Chlordane that have been developed within recent years-- are effective and probably less expensive to use than the lead arsenate at the present time. Both of these materials have the advantage of killing much quicker and will kill for as long a period as lead arsenate. So at the present time I think it would be advisable in all cases to recommend the use of either DDT or Chlordane for controlling this group of insects rather than lead arsenate which has been recommended for a long period of time. However, lead arsenate is still a very good control for either one of these three groups.

So far as the use of DDT and Chlordane is concerned, the dosages are somewhat variable depending largely on the conditions under which it is to be used. In general DDT should be used at the rate of 25 pounds of actual DDT per acre. In other words, if you are using 50% concentrate of DDT that would require 50 pounds of DDT concentrate per acre. This treatment is known to be effective for as long as five years. That is about as long as we have had the material available for turf and is still proving to be effective for the control of white grubs on turf areas that were treated some five years ago. The material can be used either as a spray or dust. The preferred method of application will depend largely on the extent of the area to be treated. Extensive areas perhaps could be treated better by spraying. For a spray use five pounds of a 50% wettable DDT powder per 100 gallons of water. It would take approximately 1000 gallons of water to thoroughly spray an acre of turf. As a dust a 10% concentrate should be used.

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CONTROL OF TURF DISEASES

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In this free country of ours where competition for the best is so keen in many lines, competition for the best also enters into golf courses. In an effort by the greenkeepers of the individual courses to have the greenest, finest and best grass, they run into many problems, problems in which we in the chemical industry are primarily concerned. This effort to grow the greenest, finest, best turf coupled with weather lead to their problems. The weather plus the green chairman are the most important factors in determining how much work the greenkeeper has to do.

Let's get down to specific problems. Often during late June and all through July and August, 99.9% of the population struggles for a breath of fresh air. It is very hot and the humidity is high. A few of us in the trade know that this hot, steamy heat is very conducive to a fungus disease of grass known as large brownpatch. Large brownpatch is the scourge of greenkeeping especially in the East, not because it is so difficult to bring under control but because when it

hits the green, it covers such a large area and literally wipes out the area it hits from the surface of the ground to the end of the blades of grass. Large brownpatch is caused by a fungi belonging to the genus Rhizoctonia. It occurs in soils and when it is resting it is in black bodies known as sclerotia. These sclerotia will spread about by composts on golf courses.

Large brownpatch can be recognized by the following symptoms: dead areas in the green usually from five inches to two or three feet across. The dead areas occur first as somewhat circular brown spots. Around the border of new brownpatches where the fungus is still active and spreading, a dark ring or smoke screen will frequently be found. Within a day the dark ring disappears and the grass becomes a reddish-brown. The disease occurs in the summer when the lowest night temperatures are about 70° F. and the humidity is high. A factor that we have observed lately is that the ground has to be wet coupled with high humidity in order for large brownpatch to go to work. In some areas where the ground was very dry but the weather was warm and humid, the greenkeepers weren't bothered so much with large brownpatch.

Large brownpatch under favorable conditions attacks most grasses used on golf courses and lawns especially the Colonial and Seaside bents. Washington bent seems to be the most resistant. The standard control for large brownpatch was simplified when the organic mercury products were developed. They are easily used as a preventive. Spray at the rate of one pound of Tersan to 6000 square feet applied with a power sprayer with 50 or 60 gallons of water. In severe weather conditions you may have to double that and use two pounds with the same amount of water. If you don't have a power sprayer, it will probably take 100 gallons of water for the same greens. The greens should be sprayed in both directions in order to get adequate coverage. The advantage of using the organic forms of mercury is that there is no danger of burning or discoloration of the grass. There is no evidence of accumulation in the soil because of toxicity. Other chemicals used are the mercuries such as Special Semesan used at the rate of one pound for 6000 square feet with the same amount of water as Tersan. Inorganic mercuries are used on golf courses and sold under several names such as Calo-Clor. These are very effective. They are risky due to the straight inorganic content and in many cases injury from the chemical is worse than the disease. They are usually used at one

ounce to three ounces per 1000 square feet depending on the weather. They should be watered in.

There are factors in the prevention of large brownpatch such as to avoid the excessive usage of high inorganic fertilizers such as sulfate of ammonia which promotes soft, tender growth which is susceptible to the disease. Keep greens opened up by the use of the Aerifier which has demonstrated its value in keeping the plant roots supplied with air and facilitating drainage. Use a pruning shear to provide air drainage around the green. In other words, eliminate some of the shrubs. Large brownpatch is favored by an acid soil. Keeping the soil near the neutral point will discourage the disease. This is not much of a problem in Central and West Texas.

The second and less troublesome disease which is hard to control is dollarspot. This disease is spread by sclerotia and possibly mycelium by any traffic on the green. Dollarspot is different from brownpatch in that it can be recognized by the small, round bleached out spots on the turf about the size of a silver dollar. That is where the disease got its name. These spots don't occur in sizes; they simply multiply and the turf looks like the moths had been in it. It usually occurs in two seasons during the summer-- one early in the growing season and another later on in the season. This cycle occurs because the fungus causing the disease grows best with cool temperatures and high moisture. If it occurs in mid-summer, it is usually found in cool, shady spots on the golf course or after cool, wet periods. It attacks most grasses found on golf courses and lawns. Washington, Seaside and all strains of Colonial bent are susceptible. Most strains of velvet bent are resistant.

The control of dollarspot hit a high a few seasons back with the introduction of the new inorganic cadmium compounds. They are known as Crag and Dupont 531. They can be used wet or dry with three ounces of the chemical to five gallons of water per 1000 square feet or dry at the rate of three ounces to eight or ten quarts of sand per 1000 square feet. Watering and poling in after applications are unnecessary and applications are usually made every ten to fourteen days. Puraturf 177 is used similar to Crag and 531 and has given good results but it is most costly. Tersan in general is not too good for dollarspot. However, once in a while a greenkeeper will swear by it. Where the mixture of mercury is used, it is as good as with 531 but the burning of the turf is a risk you

have to cope with. Some greenkeepers like Special Semesan.

A preventive measure is not to allow your greens to get too low on a fertility level. If the golf course is in an area where dollarspot is present, trying to cut the fertilizer budget too low will also cause trouble.

Another pest that greenkeepers have to worry about is snow mold. A couple of years ago we saw it on one golf course in Dallas. Snow mold is caused by a Fuserian fungus which exists in most soils. It occurs in irregular circular patches not more than twelve inches in diameter. The spots are a dirty white or gray color and have a pinkish cast. Individual plants have a bleached appearance and when they are wet, they have a slimy feeling. The leaves are mainly attacked by the mycelium and they may become so abundant that the leaves mat together forming a thick layer over the affected area. This kills the grass and roots and makes resodding necessary. It occurs in late winter and early spring. Ideal conditions for its development are long persistent snow coverings. When the snow melts, the disease flourishes under the conditions of high moisture, high humidity and low temperatures. In Florida and the south where the disease grows without snow, it is due to the cold, wet weather that sometimes occurs.

Snow mold attacks all grasses used on golf courses and lawns. Most bentgrasses are susceptible but some strains like Washington, the Colonials show resistance. The best and most economical control of snow mold is the inorganic mercuries applied at three or four ounces per 1000 square feet. Tersan at eight ounces per 1000 square feet is very nearly as good as Special Semesan at five ounces. The treatments should be put on after the first frost or just before the ground freezes and snow wets in. The pH of the soil should be neutral and fertility kept up.

Now this next one-- copperspot-- is a new disease of turf that was first noticed in the summer of 1942. The spots are smaller than dollarspot, but they run together to form irregular copper colored areas. The dead grass is copper colored instead of a bleached straw color like the dollarspot. When the grass is wet with dew, pink or reddish jelly-like fungus masses occur. These are the size of pinheads and can be seen on the leaves. During the day they are dry and hard to see. 531 or Cadmium has been recommended for cop-

perspot and is an effective control of this disease.

Another disease is helminthosporium. The disease area appears first as irregular thinned out patches without definite margins. The grass at first has a bluish cast and later the leaves darken and wither away. In severe cases only the stolons remain and the greens appear bare on top of the ground. In less severe cases the grass blades appear reddish brown. Only the top will be killed but the stolons send up new growth much slower than in the case of large brownpatch. The disease occurs under cool temperatures and high humidity. Metropolitan bent and Poa annua are the most susceptible. Velvet bent is the most resistant.

There is no satisfactory control by chemicals. Preventive measures are to avoid excessive nitrogen fertilizing, avoid excessive watering and maintain aeration and air drainage.

Pythium is named for the fungus causing the disease. To be effective it requires high temperatures and plenty of moisture. It occurs primarily in the middle Atlantic states. It is confused with brownpatch but it has a redder shade of brown and kills all grass in the infected area. The spots are irregular and in some cases have a smeared appearance. Water distributes the spores.

Major turf diseases are brownpatch and dollarspot. Brownpatch is well controlled with Tersan, Calo-Clor and Special Semesan. Dollarspot is effectively controlled with 531 or Crag turf fungicides. Calo-Clor and Special Semesan are also effective. The best results in general are obtained by spraying with a power sprayer. Fertility levels should be maintained but not over done. Soil pH should be near the neutral point. Air and water drainage should be thorough.

I want to say a few words on another subject which comes under the heading of diseases of grass and these diseases occur before the grass ever comes out of the ground. I refer to a new practice now gaining some recognition and that is the treatment of grass seeds before they are planted. The application of chemicals to seed to control plant diseases such as smuts of grain is an old and established practice. However, the chemical treatment of grass is a new recommendation. It has not as yet reached universal acceptance. The introduction of new agricultural practices is almost always accomplished with difference in opinion as to the merit of the new material or method. Inevitably

there are misunderstandings and misconceptions of what may be expected of it in the way of better crops or more products. In the field of seed treatments we can recall numerous instances in which investigators differed widely in their opinions r egarding any product or practice. The treatment of any agricultural crop with disinfectant, though it has been a standard practice for 100's of years, is just now gaining widespread acceptance. Difference in opinion about the advantages of treating the seeds of grass naturally is to be expected. Usually these differences are due to the lack of sufficient information or mis-information or misunderstanding of the principles and claims made for the new practice.

It is probably not true that treatment of grass seeds will always pay. It is undoubtedly untrue that the thing never pays. Somewhere between is the truth. I know you are going to be interested because many of you plant rye grass in the fall to have nice green turf through the winter and many of you seed your bents and bermudagrass. In order to understand this job of seed treatment I think it would be well if we would consider the seed itself as it is planted.

This seed consists essentially of a young plant in the embryo stage. It is often called the germ. It is more or less surrounded with a supply of carbohydrates and other substances sometimes called the starch. The sturdy part of the seed represents the food on which the germinating seedling must depend until it has emerged from the soil and developed its own facilities. Once it has been planted in the soil each seed is on its own. The seed must either produce a plant from its own resources or it must die.

The other principle involved in this problem of establishing seedlings is the soil. If we take for granted the soil contains some chemical plant nutrients and moisture, then we are not in a position to understand the process. It is necessary to know that all except the most infertile soils are teeming with living organisms in the form of fungi, bacteria and protozoa. Some of these microscopic organisms are unimportant to the seed. They neither help nor hinder the formation of the seed. There are other types of organisms in the soil that are beneficial and absolutely necessary to the growth of seedlings. I refer to that group as the bacteria. But there is still a third group of micro-organisms many of which are not well-known except for the harm they do to the seed. These are the parasitic organisms that attack planted

seeds and seedlings causing the seeds to decay and the seedlings to damp off. These parasitic organisms are hardy. They can thrive in all soils surviving the winter, heat and drought in the summer. We can not kill them without at the same time killing the friendly organisms essential for the growth of the plant. Our only resource then is to learn how to grow our crops in spite of these pests in the soil. This brief description of the seed in the soil may enable us to understand better the situation which confronts the planted seed.

Let's go in closer and watch the contest between the seed and these parasitic organisms. The planted seed begins to absorb water from the soil. It softens the seed container. The seed container ruptures and the tiny sprout and root pushes out into the soil. This is the big moment for which the enemy has been waiting. They move in and attack the defenseless seedling. If the attack is vigorous, the young sprout may be quickly destroyed and reduced to a rotted mass. If the attack is less vigorous, the seedling may survive but much of the stored food will be destroyed by the enemy invaders. In that case the seedling must struggle along as best it can on a reduced portion of the stored food. This means that seedlings are slow to emerge from the soil and have a weak growing ability after they emerge. These weak seedlings can be seen in almost all stands of grass. After a feeble effort they usually die, or if they do survive, will produce a low return.

In this battle between the germinating seed and its parasites the seed often fights at a disadvantage. Conditions unfavorable for growth such as low soil temperature or too much or too little soil moisture retard germination and prolong the critical period in which the seed is subject to attack. In such cases more than one seedling will succumb to the battle and the stand will be poor and unprofitable. Then you will find that you will have a poor stand of grass. You are confronted with the problem of whether to plow it down and reseed or what to do with it.

Now here is where we come to the point of the story. Let's say we are going to do something about this. Where does chemical treatment fit into this picture Suppose we intervene in the struggle and take steps to handicap these parasites. This can be done by coating the seed which is harmful to the parasite but harmless to the seed and seedling. This chemical is a protec-

tive barrier and kills the nearby parasite or at least checks the attack until the seed can germinate and the seedlings can emerge above the ground and become established. There we have the simple explanation of why suitable chemical treatments often increase the stand of grass and frequently increase the vigorous and hardy growth of seedlings. These benefits account for the increased yields in forage crops when they are planted on the farm.

We began this talk by referring to the confusion and misunderstanding that frequently surrounds the introduction of a new agricultural practice and pointed out that grass seed treatment was no exception to this rule. By attempting to show what grass seed treatment does accomplish, we would like to make these things as clear as possible by citing some of the things we can not expect chemical treatment to do.

First, seed treatment is not a fertilizer. It does not feed the germinating seeds. Second, as far as we know seed treatment does not stimulate or speed up germination. There may be exceptions to this. Third, seed treatment does not improve germination. It cannot restore life to dead seed. If the germination of a given lot of seed is 75%, it is still only 75% after the seed is treated. However, more seed germination is almost always accomplished by a large percentage of weak seed. Very often the protection given these weak seeds will enable them to germinate and produce seedlings which they could not do without seed treatment. Fourth, seed treatment is not a substitute for high quality in seed. Neither does it lessen the importance of proper attention to seedbed preparation.

An important question in connection with seed treatment is not so much what it will not do and what we must not expect of it, but rather what the farmer can expect from it or the man who does the seeding. He can expect a good seed treatment frequently to increase the number of seedlings by reducing the large number of seeds that will rot in the soil. In other words, you are putting that protection around them which gives them a chance to survive. You can expect stronger and more vigorous seedlings through the reduction of weak seedlings. As a result of the improvement just mentioned, there should be fewer failures in getting a good stand of turf. There should be fewer cases in which seeding is irregular.

As far as the seedsman is concerned, I would like to say that if you use these treatments, you can expect

several benefits. First of all the difference between the percentage of seeds which will germinate as shown on the tag and the percentage of the turf that the greenkeeper obtains is quite different. The more unfavorable the soil conditions, the seeding time, etc., the wider that difference is, seed treatment will help close that gap. The wider the gap, the more important and beneficial the seed treatment. Seed treatment should result in fewer complaints regarding seed quality which is usually not the result of the seed itself but of those adverse soil conditions. Most kinds of grass are rather expensive. By comparing the cost of seed treatment which we will say is ½¢ of chemical a pound, it is plenty of insurance. Without seed treatment you have not taken all possible steps to present the customer with the best possible seed.

I haven't told you what to treat the seeds with. It so happens that Thiaran products have given consistently best results for grasses. The favorable rate of application is 8 ounces to 100 pounds of grass seed. That is because the surface is so great. It should be thoroughly mixed so that each seed is coated

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CARE AND MAINTENANCE OF SCHOOL AND PLAYGROUND TURF

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I really don't know what to say to a group like this because I know everybody here knows a great deal more about turf than I do. However, we do have a lot of problems. Some of them are the same as yours and some may be different. I thought the thing that would interest you most would be to outline our problems and go over our solutions that we have found to be rather effective.

When you think of campus turf, the biggest problem that we face is student traffic. It is quite a problem due to the fact that it is impossible in my opinion to keep them from wearing paths through the lawn areas. We don't endeavor to do anything about it because in the past it has been the opinion of many people that all you had to do was build a walk wherever they make a path and the problem is solved. The only problem is that when you build that walk, they cut a path between that and the other existing walk. You don't get very far. Actually the compaction that you get on a turf area plus these walks makes maintenance from an appearance standpoint almost an impossibility in some instances. We are faced also with the problem of appearance which has a lot to do with upsetting a lot of our maintenance programs because of it had rained in the last year around here and we were cutting grass only two days ago, we would cut it again for this conference just for appearance. Also we lose a good bit of organic matter from the standpoint of the leaf area that is lost and also the clippings that we try to leave on as much as possible because that is the chief source of organic matter.

We have a serious problem from the standpoint of drought and water relations because the turf on the campus has been neglected. We have a problem of fertility and nutrition that is probably the worst thing you could get into. There has been no commercial fertilizer of any kind applied to any area in 20 or 30 years. As a result, we have a good many thin areas which makes weeds and other plants quite a problem, especially dallisgrass. I was talking to the Dean some time ago and he said that they considered dallis-

grass an excellent pasture grass but it is very difficult to get started. We find that it is a very excellent weed and it is almost impossible to eradicate. We did have some material here on an experimental basis this year which may be of interest to you. It did a fair job of eliminating dallisgrass last season.

Another major problem that we have is that of labor costs. We either have an insufficient budget or an insufficient number of men-- usually both. Our budget is based on the number of students in attendance with the assumption that the campus gets smaller as enrollment falls off and larger as it builds up. That does not work well in fact. We are faced with that to some extent. The labor has to be transitory because of that and we are faced with the problem of using quite a few men when we need them and having to let them go when our major operations in maintenance fall off. The result is that it is very difficult to get anyone who knows what he is doing. In general that has been our particular problem. We normally have plenty of rain here. We have had plenty of rain this year but we had it all at once and haven't had any since. That again makes a very difficult situation to plan any particular programs of maintenance.

With that outline of the thing that we must consider to be a major problem, I would like to tell you what we try to do to solve most of them and in some cases it is things that may be of some interest to you. I think the biggest thing--. and you should be interested in this-- that has happened on this campus was to gain student cooperation and get them on our side. That program is very vigorous here at the present time. The best part about it is that it was self-stimulated by the students themselves and is the fact that we built this lawn around this particular building. I don't think there has been one student walk on it since the grass came up. It has been more or less a stimulation to get them to try to keep the students off some of the other areas. It worked very well. The hardest, longest and widest paths we have on the areas we have tried to renovate have been made by staff members. They kept the cadet corps off those areas pretty well. As far as this job of student compacting, I think the only logical way to combat that is to get the cooperation of the students themselves. I think if you are interested in campus maintenance, that is the answer as far as the student problem is concerned.

We also have a thing that helps quite a good deal in bringing turf back into the areas where it is worn off

by student play due to the fact that we have a rather small summer enrollment. In the summer months that turf has an opportunity to come back. With bermuda, which we try to use entirely, it comes back rather strikingly during those summer months. Another thing which I think would be of benefit which we haven't been able to try yet because of the drought are these Aerifiers which we intend to use.

We have another problem which is quite serious here and that is the fact that all of our drainage systems are on the surface. That gives us a serious erosion consideration as well as a loss of fertilizer, seed and everything else if we happen to be doing any work at the time it rains. Incidentally, that falls out of our line of activity and until we can get the drainage lines and facilities underground, that is going to remain a problem. We are trying to do it slowly with our own funds. That is a long-time job. If you are faced with a problem like that, you have a bad situation as far as some areas are concerned because the wash and erosion is just too great to do much with.

The big problem is to renovate these turf areas which have been neglected for so many years. We believe that we have that problem solved economically and feasibly and successfully. That is the thing that I imagine you people would be most interested in. We take an area of the campus at a time and tear it up completely in order to aerate the soil and to stimulate what little bit of organic matter we have and on smaller areas we are trying to add as much as we can. On the larger areas if the supply holds out, we intend to cut as much of any material as we can get into it. However, the aeration alone has proven a stimulant to the growth of grasses. With a systematic feeding program it is surprising what wonders you can work with merely tearing up these areas where you have a poor stand. We have done this for two or three years at the campus annex and find that it worked very successfully. If you have been walking around the campus, you have probably noticed that we have a few large areas completely torn up. Rather than try to explain the steps to you, I have some slides and will try to go over with you the various steps we use in bringing this renovation program into operation.

This first slide will give you an idea of how some of these areas looked after this drought. They are pretty well compacted and very little grass is left. The machine that we used on these larger areas is an Adams

motor grader and it is equipped with a grading blade and also scarifier teeth. The second operation that we go into in renovation is to tear the areas up with the scarifier teeth. You can see these right behind the wheels. They go into the ground and you can see in the next slide that the teeth are really tearing the soil up. We go over the soil in two directions with the scarifier teeth. That tears it up to a depth of six to eight inches. That is the way it looked after they got through with the teeth.

Then we go through a process of discing that material both ways. We go over the entire area two times each way. The purpose of that is to cut the bermuda stolons into the smallest pieces possible so that when they come up again-- and I assure you it will-- you get a fairly even stand of grass. In those areas that are completely worn out and killed, you will get a very even stand when it is sown with new seed. You can see that after it is disced up you have a very good seedbed and that area that you are concerned with for the growth of plants is pretty well aerated by using this equipment.

In some areas we run into a great deal of gravel and stone. This shows that area after it had been watered. We have a portable sprinkling system. You can see how smooth and level that area is merely because of these cultivating operations and one application of water that we had to provide because we had had no rain.

You might be interested in the development of this lawn. It was turned over to us rough graded about the tenth of September. We have it completely graded and green by the 21st or the day they opened this building.

I believe that some method of irrigation will have to be practiced if you get into programs like this. This portable sprinkler system is a good thing. You can carry a length of that pipe under each arm. It is very light and very efficient. If it doesn't rain before the first of next week, we plan to irrigate the field across the street with it and see if we can't get a cover on it.

Our feeding program perhaps is a rather different one from you fellows. In five or six years we find that a little study of the characteristic growth of plants in this area saves us a lot of fertilizer. So we feed fairly heavy in the spring when the grass first starts active growth with a 5-10-5. I am not selling ferti-

lizer. The other material we use is Milorganite. The thing we like to do is use the 5-10-5 to give it a quick kick to get it started and then follow with a quick application of Milorganite which is organic and is more slowly available than the other material and it will carry on into the summer months. If we continue to get moisture, we may apply that 5-10-5 twice or three times up to perhaps the middle of June. Then we stop feeding entirely until the beginning of October. Normally we expect a little rain about that time. We reverse the process of putting the Milorganite on first and then as late as we think it safe, give it a last feeding of 5-10-5.

We also follow the practice of cutting our grass fairly high in the summer time for which we get a lot of criticism. We like to stick to two inches because it is merely a matter of actual plant growth as we see it. We have too little top on the plant anyway to manufacture food and during the summer weather here by actual tests the respiration in those plants is the same as it is in any other. It exceeds the full synthetic weight anyway. As a result, the plant is in no condition to absorb the fertilizer. It is always using a lot more food than it can make. As a result, if you continue to feed heavily at that time when all of the plant processes are waste processes rather than productive, you do the plant more harm than you do it good during those summer periods. For that reason we try to keep as much leaf area on the plant as we can to aid that photosynthetic process which is food manufacture. In that way we keep the grass as healthy as we can. Actually that is our critical period. We think that is important and it has worked for us. That is more or less the program of mowing that we follow.

As far as the renovation program is concerned, two years ago we had a serious drought. We tore up big areas just 12 miles out of town. It had more bermuda the next spring than it ever had before. We find that sort of thing is the best thing you can do for it and is probably the cheapest.

The way we beat the labor situation most successfully is to go into the use of good equipment and fewer men who you can afford to keep on and train a little bit. We are now cutting ten times the area that has ever been cut before on the campus with about 1/10 of the men.

I think our biggest problem is the same as for you. In the last analysis it is a question of public educa-

tion. When people begin to realize that the only way they can keep the dust settled and take care of a better environment around homes or buildings, the sooner they begin to realize that good turf is more of a necessity than a luxury, a lot of our problems will be solved.

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AERATION OF TURF

O. J. Noer
Milwaukee Sewerage Commission

On my way to Tulsa I read an article written by Mr. Langdon. He has been chairman of the golf committee at Sleepy Hollow in Westchester County for no less than 25 years. Last year and the year before as a member of the Maidstone Club on Long Island he undertook to help with maintenance on their grass tennis courts. In this connection he visited most of the tennis clubs in the east and prepared a digest of their maintenance methods. I was impressed with the postscript he placed at the end of the article. I shall read it to you.

"I believe we sometimes forget that the best turf is maintained when we cooperate with nature, treat it with consideration and remember that grass, like people, suffers from excessive heat, high humidity, overwork, a badly balanced diet, over and under feeding, submersion, thirst, insects and disease. Less harsh treatment is a point to keep in mind when selecting and applying fungicides, fertilizers and so forth. If they are to do the job, use bland ones especially in mid-summer. And a word to chairmen. I would go slow about bringing in new methods that are reasonably opposed by the groundsman. The job is his livelihood and he must move cautiously or he may lose it. At the same time I believe most groundsman recognize progress when they see it and will readily adopt what they believe to be good."

I presume if one were to ask the question "What makes the grass green" a resident of Alaska would stress sun shine and warm weather. In New Mexico where they have plenty of sunshine and warm weather their answer would be simply water. Florida has warm weather, sunshine and a reasonably good rainfall, so the answer there would be plenty of fertilizer including not only the major but also the minor elements because the white

sand in that state is simply a medium in which to anchor the plant. It is necessary to provide all the nutrients needed for growth.

In 1949 we had a bad summer for grass in the north. Much turf was lost that season. It was easy to understand why grass wilted on the many greens where root systems did not extend below a half or 3/4 of an inch. On a hot, windy day, soon after sunrise the grass started to turn blue, and unless a little water was applied promptly, and several times a day, the grass withered and died. On the other hand, I visited some golf courses where I knew the roots were down where there was plenty of moisture. As a matter of fact, there was an excess of water in the soil. Yet the grass was wilting and wilting badly.

In early September Marvin Ferguson and I attended a plant nutrition symposium in Madison, Wisconsin. He called my attention to experiments conducted by Dr. Hoagland at University of California in Berkeley. Tomatoes were grown in water culture. In some of the jars the tomatoes were wilting despite the fact that the root system was wholly submerged in water. In other jars there was no evidence of wilting and the tomatoes were growing in a normal manner. The only difference between the two was that a small amount of air was bubbled up through the jars where there was no wilting. This experiment brings home the point that the medium in which the roots are growing must contain oxygen. I think Longnecker and Dr. Sprague showed the same thing with grass in similar experiments at New Jersey. Where air was bubbled up through the culture solution, there was an extensive root system and no wilting.

Many of us look at the soil as just so much dirt. As a matter of fact it is a mixture. It consists of a solid, liquid and gas. The solid fraction of the soil is made up of the mineral parts and the organic matter. Based on volume relationships, the mineral fraction is 85% to 90%, and the organic matter 10% to 15%. The solid fraction of the soil is 50% by volume. The other 50% consists of voids occupied by air and moisture. In the ideal soil the relationship between air and water is about 50-50. In other words, an ideal soil is 50% solids, 25% air and 25% water with its dissolved nutrients. We talk about waterholding capacity, the air relationship in the soil and then overlook one important factor. That is the size of the capillary voids in the soil. In other words, besides containing plenty of air the soil should have large

enough fissures so that excess water can move down and away quickly. Otherwise a water-logged condition is likely during wet weather.

On golf greens and many fairways compaction is the result of traffic, and of mechanical equipment. are responsible for many of the shallow root systems which we see around the country. I am convinced that it is not entirely a matter of faulty fertilizer practices. It is lack of air because the roots breathe and must have oxygen as you and I do.

This is a picture of a practice field at the University of Michigan. You can see what traffic wear has done to the turf. When I walked onto the field and noticed this regular pattern, I asked Charlie Mutter what happened. He said that the University of Michigan band practiced maneuvers one hour a day for ten days. See what just ten hours of marching back in the same path did to the turf.

This approach is in northern New Jersey. You can see that it is a rather sorry looking approach. It is mostly clover and poa annua. The brown spots were annual bluegrass out during hot weather, it melted out and disappeared. Then the clover started to go to town. Actually the best turf should be on the approach and not the area directly in front of the tee. I am sure in this case it is a matter of traffic from mowers and tractors because there are two traps alongside in front of the green which compels the operator to go over this area more times than is good for the grass.

This is a picture of the Soilaire machine which is an attempt to remove cores on fairways. It is somewhat similar to other machines. It takes out a solid core and doesn't do any cultivating but each unit is a separate one. The next picture shows a close-up and how flexibility permits individual units to pass over with out injury to the tines.

The next picture is one of the 3-gang West Point Aerifier equipped with spoons. It is widely used. Several years ago Milwaukee Country Club had trouble with their fairways. Large areas started to show wilt during a hot spell in August. Turf roots were shallow due to an excessive mat of grass. We suggested the use of an Aerifier. Fairways are aerified each year and since starting that practice they have not lost any grass on the fairways.

Yesterday mention was made about sand. Here is a green

at Parris Island in which the soil underneath is nothing but sand. It is very fine sand-- so fine that it packs just like concrete. They thought it was a disease on the rye but you can see that it is nothing more than wilt. They lost the grass because of the very shallow root system. Applied water didn't go into the soil. You can see the beginning of algae over on this side which is an evidence of too much surface moisture.

In August of 1949 I was on a golf course in Detroit, Michigan. All the greens on the course looked like this one. I asked if they weren't better on Friday than on Monday morning and was told that was the case. I asked the question because there were no roots under neath the turf. They didn't extend beyond half an inch to 3/4 of an inch. Unless a workman was on hand on Saturday and Sunday to syringe the grass and keep it alive, this is bound to happen.

The next picture is one taken on the same course the year following. As a result of the shallow root system, I induced the club to buy a Terferator and drill all greens several times. I should have taken an over all picture showing the turf but instead I removed a plug with the hole cutter. Notice the long, white roots that were down in the drill holes. The man in charge of the course said that he didn't have to worry nearly as much about syringing the turf in mid-day because grass seldom wilted even on hot days.

The next picture was taken in Louisville. It shows nice long, white roots down where the soil had been cultivated.

This is a good example of wilting grass. It turned blue first and then gradually turned brown, withered and died.

This is a green in the Chicago area with pronounced mid-day wilt. Unless holes are made to admit water and encourage deeper roots the grass is going to die and the whole green will look bad. Watering lightly two or three times a day to prevent wilt will save the grass until a deeper root system is developed by forking, drilling or spooning with an Aerifier.

Some years ago I was in West Virginia. The man in charge of the course was alarmed. He was told the greens had a new kind of disease and he didn't know what to do. Griffith asked me to tell him what was wrong. I thought I might as well be the goat because

I would never go back there. When I saw the greens I asked if they were ever watered. I was told they got water every night. Instead of taking a plug out where grass was brown, I went over here where the grass had that characteristic bluish color and cut out a plug. After looking at it, the pro-greenkeeper said, "Well, I'll be damned. In these new deal days even the water isn't wet anymore."

If the soil becomes thoroughly dry particularly if there is compaction, putting a sprinkler on the area is not going to rewet the soil below the surface one-half to one inch. More drastic means should be taken to restore the moisture. This shows a localized dry spot. The green was watered at night. Notice how the moisture has moved down into the soil where it was moist. Here it was bone dry, the water hasn't gone down below half an inch. Therefore, this area is too wet because it was too dry. The water that should have gone down to a depth of 7 or 8 inches stayed up in the top half inch and was responsible for the algae that you see appearing on that spot.

We talked about thatch. Many of you that develop a thick,heavy thatch on top of the greens are doing just what they do in Mexico. Instead of buying shingles, they use palm fronds to keep the water out of the buildings. That is just what an excessive mat does. When the turf becomes thickly matted, roots never go below an inch and when July and August come, you can expect trouble.

In the old days when labor was cheap, this is the way localized dry spots were eliminated. The areas were forked and drenched several times with water. Once the soil becomes moist again, it takes water in a normal manner.

This is the West Point G-L Aerifier being used for the first time at Shaker Country Club in Cleveland on the practice green. The next picture shows Colin Smith and Mal McLaren measuring the depth of the hole made by the spoons. The next one shows the succeeding operation of whipping with a bamboo pole to break up the cores. After that the green was mowed. You can see the two portions. The one had been whipped and the other hadn't. We got the pro to come out because he is a man I have a great deal of confidence in. He was in favor of aerifying, if it was good for the turf and making maintenance easier.

This is the Motoraire. I have only seen it operate

once and that was when I took these pictures on a course in Minneapolis. You will notice they are hollow-tined forks which remove a core from the green. The next picture shows Leo Feser displaying a few of the cores taken out with this machine. After using the Motoraire the soil plugs were pushed off the green with the back side of a wooden rake.

This is a picture of a tee and fairway at Milwaukee Country Club. Those fairways are always in good condition. They are the creeping bent type. They use an Aerifier and have been able to maintain and hold the turf exceedingly well. The next picture shows one of the fairways on that course.

I think Al Crain should explain this picture.

Al Crain: There is a reason for showing this. We will admit that it is too severe as far as neat renovation is concerned, but a lot of you are scared you will kill the bermuda by cultivating. The bermudagrass did better and had better turf after this machine was used and within a month it was better than any other treatment we put on. In other words, you cannot kill bermuda by cultivating it.

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FERTILIZATION OF TURF

J. R. Watson, Jr.
Texas A & M College

I am going to talk to you this morning about a subject that isn't new at all. To show you that it isn't new, I have one or two pictures that I want to begin with.

Slides

Back when the white man first came to this country, they found the Indians fertilizing their corn merely by placing a fish in the hill where they were going to plant the corn. You can see, therefore, that the subject I have to talk about this morning is certainly not new. We have a lot of new ideas about fertilization and we are perhaps approaching it in a manner different from the Indians, but the idea itself is not new.

One of the main things regarding fertilization in relation to plant production is to keep a balance of all

the factors that control the production of the plant. Suppose we let one of our barrel staves represent the supply of nitrogen. If it is limiting, our production will be no greater than this supply of nitrogen will support. Suppose we correct nitrogen. We may then find that the phosphorus is deficient. So it goes with all of the factors not only the fertilizer elements but the moisture supply, the physical soil factors, aeration and so forth.

Now I want to show you a diagram of how plants grow and see if we might base our fertilization on the manner in which plants grow. Here we have a plant that is mature. When it produces seed, we find our reserve food supply in the root system to be low. This is shown diagrammatically by the reduced root system. If the plant sets seed, vegetative growth begins to decrease and food is transported into the root system. This is diagrammatic and it involves a normal plant growing in a normal environment. This would depict the situation as regards the reserve food supply of the root system going into the fall of the year. Coming into the spring we have no top growth. It is being initiated at the expense of the previously stored food of the root system. Doctor Sprague mentioned yesterday that the leaf surface is essential in the production of food. As our vegetative growth increases, our reserve food supply decreases as shown by the reduced root system. We find a direct correlation occurring here. After the leaf surface becomes sufficiently large, it can elaborate more food than the plant needs for its immediate functions and it will begin to store food. Only after it begins to satisfy its own needs, however, will any food be translocated to he roots. Then we are back where we started. When seed production comes along, most of this food is translocated upward and used for reproduction.

Crain: Jim, may I add to what you have just said? Up and down insofar as the root system is concerned, it doesn't necessarily represent a decrease in the root system of the plant. It is a decrease or increase in the stored food. If you keep those plants mowed off so close and don't allow them at any time during the year to make sufficient growth to elaborate and store that food in the root system, you will lose a lot of plants.

Watson: Thank you, Albert, that was the next point I wanted to bring up. In our turf work obviously we do not let our plants go through this normal cycle. We come along and clip them off. The use to which we are

putting our turf, whether it is cemeteries, parks, fairways or greens, will determine the height of cut. Now the more leaf surface that we take off, the more difficult it becomes for that plant to elaborate enough food to serve its purpose and to store food in the roots. Consequently the closer we clip the turf, the more intensive our management practices must be. We must use more moisture, more fertilizer, and a better balance between our fertilizer elements.

We have shown that the great part of our reserve food supply is elaborated in the soil and that many new roots are developing at this time. Fall is the time that I feel we should put on our complete fertilizer. Certainly in the spring of the year again there are new roots being developed. By and large the most important part of that root system is developed in the fall of the year. If we have a complete fertilizer applied in the fall, aerify in order to enable the phosphorus and potash to get down to the roots-- it won't do us much good if it remains on the surface, we must get it down into the soil-- then we have taken care of two very important steps in the production of good turf. I have already said the use to which our turf is put is going to govern the amount and kind as well as the ratio of fertilizer that we are going to use. The other thing that will govern the amount to apply should be based on soil analysis. Since the first of November a soil testing service has been available here at the college. You can send a sample in to the soil testing laboratory and they will give you a chemical analysis of the soil for one dollar. You have to send in a sheet giving the necessary information and the men in the lab will interpret it. These forms may be obtained from your county agent. Soil analysis can be a starting point. Remember that the type of turf needed is going to be the ultimate determining factor as to the amount of fertilizer that should be applied.

I want to talk a few minutes about nitrogen. To me the management of nitrogen is the key to successful turf. I think it is the most important of the three major elements. All of you are aware that there are basically two types of nitrogen -- the inorganic or soluble forms and the organic or relatively insoluble forms. I have a slide I would like to show you now. This is actually a slide of the results of some work that was done while I was at Penn State. A number of materials were tested for the availability of nitrogen from various carriers. There was adequate phosphorus and potash applied to the area and the only thing that

was different was the nitrogen carrier. There are a number of ways to find out how nitrogen is being released from any of these carriers. Since top growth and nitrogen are very closely related, we chose yield as the measure of the availability of nitrogen from these various carriers.

The first three that you see here are compounds of urea and formaldahyde. They carry the name of urea-form. These materials are inorganic as far as their chemical constitution is concerned, yet they act as organics. They can be formulated to release all their nitrogen just as readily as ammonium sulfate or to release some of the nitrogen early in the season and the majority of it in the latter part of the season. They can be formulated where they are totally insoluble as far as plants are concerned.

We would like to see plant yield remain more or less uniform throughout the season. Let's see how some of these materials held up in that respect. This first slide shows 1½ pounds of nitrogen per 1000 square feet. These show the relative yields in terms of the check that had no nitrogen. The check treatment was taken as zero. You can see how our material held up. Notice that on the 24th of September there was adequate nitrogen to support growth. This next material apparently was not as desirable as the G-6 material. This was designated as G-7M and carried about 20% of soluble urea. That is evident here. In the first clipping there was a much greater growth. Nevertheless, it began to drop, however, it did pick up toward the latter part of the season. That isn't the whole story. I should mention that these plots were not irrigated that year. Along about the last week in August we got a little rain and that helped. This is evidenced by the increase in yield shown.

Let's see what happened with some of the other carriers. Our old standby has been Milorganite and it might serve as a check. It is somewhat more readily available in the initial part of the season than the G-6 material, yet yield from this plot dropped down in these periods of low rainfall to a point below the check. However, when moisture became available, yield went back up. There was still nitrogen available in the latter part of the growing season.

Let's go to ammonium sulfate. Here is what you can expect from the soluble types of nitrogen when you apply them to turf. Ammonium sulfate is a tremendous

stimulant. In the spring we already have a build up of nitrates in the soil. We have a lush period of growth in the spring and if we apply heavy amounts of soluble nitrogen, we are just over-stimulating that growth. By the middle of the season we are down to where the fertilized plot was no better than the check. In the latter part of the growing season, our sulfate plot never came back up. Actually yields were not the complete story. We found that the quality of that turf was inferior to the quality of the turf in the check plots. The plants were over-stimulated in the spring and there was no nitrogen left by the fall of the year.

Here is a slide showing yields from three pounds of nitrogen per 1000 square feet. After this particular test was under way, we concluded that 1½ pounds of nitrogen was not enough. We also concluded that three pounds was too much. I believe the next year we settled on two pounds. Again that amount is going to depend on the fertility of the soil as well as some other factors. Here was a grouping of the clippings on the first of June. From the 12th to the second of July, you can see what happened. Here is the ammonium sulfate and Milorganite and here are our three synthetics. The G-6 and G-8 were holding up very well. The Milorganite was still more active than the synthetic and the sulfate was more active than all of them. From the 24th of July to the 14th of August, our G-6 material was still holding up very well, the G-8 was beginning to drop and the G-7M had apparently lost its effect. The Milorganite was somewhat above the check and the sulfate was above. From August 14 to the second of September our G-6 was still looking very good and our other two synthetics and Milorganite were looking very good, but our ammonium sulfate dropped below the check. This is the next group from the 3rd of September to the 24th of September. Notice the performance of the G-6. It is still way up in front. The ammonium sulfate kicked back up during this period but it was still not up to the check.

I don't want to leave the wrong impression with you. We can manage these soluble types of nitrogen. The thing I want to bring out is that we must manage them. Here this material was put on in the beginning of the season. That is not the way to handle your soluble types of nitrogen. You simply cannot do it. You will have this situation of over-stimulation in early spring and poor quality turf in the fall. The following year we applied two pounds of nitrogen per 1000 square feet. We put on ammonium sulfate at the two

pounds and applied ½ pound of nitrogen from ammonium sulfate in four applications during the growing season. We held up our growth and we held up our turf quality very nicely. In other words, by proper management and proper utilization of these soluble forms of nitrogen, you can get the job done. One drawback to the organics is the price as compared to the inorganic or soluble types. I am not telling you which one to use, but I am merely pointing out some of these factors. If you do use the soluble types, certainly exercise a little caution in the way you apply them. They will burn your turf very readily. Organic carriers will burn but not as readily as the inorganics.

I will briefly give you some very general factors for fertilization of these various turf areas. For golf greens I feel that perhaps three pounds of nitrogen, 1½ pounds of P_2O_5 and 1½ pounds of K_2O per thousand square feet in the fall and about one half this amount in the spring is a good general rule of thumb to go by. Then in addition to the complete fertilizer, you will need to apply supplemental feedings of nitrogen during the growing season. We like to see complete fertilizers with half organic and half inorganic nitrogen. You need some inorganic nitrogen in the material to give you immediate stimulation. The organics stay with you a little longer and provide nitrogen after the solubles have been dissipated. Remember I am talking only of greens now. The type of nitrogen you use will govern the frequency that it will have to be applied during the growing season. Somewhere between 3/4 and one pound of nitrogen per thousand square feet every twenty to thirty days is probably best. Put on a complete fertilizer in the fall. I am a strong believer in fall fertilization.

For the fairways I would apply about two pounds of nitrogen, 1 pound of phosphoric acid and 1 pound of potassium from a complete fertilizer in the fall. If your budget will stand it, half this amount in the spring. Perhaps no supplemental feeding of nitrogen will be necessary, however, if the grass goes off color, put on some nitrogen but not a complete fertilizer, only the nitrogen is necessary.

I group cemeteries and parks together. Those areas to me are the real problems. Most of the parks and cemeteries don't have an unlimited budget. Finances are more or less restricted. They have to develop a turf and I think with a minimum of expense. One of the first things I would say is to clip the turf about two inches high. If the clientele kicks, let them kick and

try to convince them that this height of cut is necessary. If it can't be done, then lower it to 1½ inches. You have made a great improvement.

Put on about 2 to 2½ pounds of nitrogen from a complete fertilizer with a 2-1-1 ratio in the fall of the year. If I could only make one application, fall is the time I would make it on cemeteries and parks. The amount and kind of fertilizer to use is going to be determined by the inherent fertility of the soil. I think it would behoove any one working with cemeteries and parks to have their soil analyzed. I think here is a place that it would certainly be of value. We all know that golf greens must be fertilized but on the cemeteries and parks I think it would be a very good thing to have your soil analyzed and then base your fertilizations on that soil analysis. In mid or late spring I would apply a second fertilization at about one half the rate used in the fall. Putting in on at that time avoids over-stimulation because you already have a build-up of nitrates and you have built up a good reserve food supply. You have good growth in the spring. If you come along and put on additional fertilizer in early spring, I don't think you are helping the situation as much as if it were applied in mid or late spring. That is the only time that I would recommend fertilization of cemeteries and parks. If something is coming along and you absolutely have to get them in good shape, if it is off color and so forth, use nitrogen as a supplemental feeding. By and large, I believe if you will follow this program, your turf will be satisfactory.

I haven't mentioned how to apply these. It has been mentioned by previous speakers. I would like to see all of it applied in conjunction with aerifying in order to get the phosphorus and potash down to the root zone where it is needed. These elements aren't going to do you much good on the surface of the soil. The nitrogen can be applied on the surface, and it will leach down into the soil. But for phosphorus and potash, no. You must get these into the root zones so they should be used in conjunction with aerifying.

Question: What would you consider a fall application?

I would say that it was some time from the first of September to about the 24th of September here at College Station. If you are farther north, it would be earlier. If you are farther south where the first killing frost doesn't come along until mid December, you can wait longer. I would say the fall fertiliza-

tion should be made about 4 to 6 weeks prior to the first frost.

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WEED CONTROL BY USE OF CHEMICALS WITH SPECIAL EMPHASIS ON CRABGRASS CONTROL

Marvin Ferguson
USGA Green Section

It was my pleasure to be able to attend your first turf conference down here in 1947. In that year my job was to talk about weed control. I went back and looked up some of my old notes on that talk to see what I might have said in 1947 about weed control and it makes me think that I haven't learned much since. I found that I broke the subject down into two phases. I talked about weed prevention and then weed eradication. Weed prevention is unspectacular. It is a rather slow process but nevertheless it is the most important of the two. If you eradicate weeds that you have, then you must go into a program of weed prevention or you will get them right back again. If you practice weed prevention in the first place, then perhaps you won't find it necessary to go into a program of eradication.

The previous speakers on the program have pretty well covered the practices that go along with weed prevention. There are a number of those practices such as choosing the right grass and Dr. Sprague gave us a very good talk on that subject the other day. The right grasses certainly go a long way in keeping weeds from encroaching in your turf. There has been a saying among greenkeepers that to prevent weeds, you should grow good turf. That sums it all up in just a few words. If we could just grow good turf, it would be a simple matter. But as you all know, there are a lot of things that go into the matter of growing good grass. Management plays a very important part. Good management means proper fertilization and mowing the grass at the right height and practicing good insect control and good disease control. Anything that you do to scar a turf area will allow weeds to encroach. Anytime turf becomes thin, weeds will come in.

I noticed in the title of this talk that we were to give special emphasis to crabgrass control by chemical

methods. I believe that a few years ago we might not have put that in a program as the title of a talk. We wouldn't have given special emphasis to crabgrass control. I have been in this work about ten years, having started with the Green Section in 1940 and at that time very little emphasis was being given to crabgrass. It was just as bad a weed then as it is now, but we had many other weeds that plagued us. We had dandelion and plantain. Crabgrass was a bad problem but we had so many worse ones that it didn't bother us much. Since 2,4-D has come along and we are able to control most of these broad leaf weeds, we have begun to worry about crabgrass. There is a frantic search now for some chemical that will do the same thing for crabgrass that 2,4-D has done for the other weeds. I don't believe we are going to find it-- not anything as effective as 2,4-D. I think we will find some chemical that will be effective for crabgrass control. We already have some that are quite effective when used properly, but it takes much good judgment on the part of the operator in order to successfully eradicate crabgrass.

I expect most of you have seen this. It is crabgrass. The picture was taken in September. This was a wonderful stand of turf the year before but after crabgrass has died off and has begun to thin, it doesn't take much traffic before you are in the mud. You can't think of it as being much of a turf.

We talked about growing good grass and choosing the right grass to keep crabgrass out. Here was a patch of solid crabgrass at Beltsville. It was an old crabgrass control plot. On this particular plot a chemical was used that not only killed the crabgrass but it killed everything else. Then the following year there wasn't anything at all on the soil so it came up solid crabgrass. We decided that would be a good opportunity to test some of the grasses that we have developed to see if any of them could spread and hold their own in that solid crabgrass. These plugs were planted in the spring. In the fall this is the area covered by C-115, Dahlgren bent. Dahlgren bent is one of the most vigorous bents that we have worked with at Beltsville in the last few years. We don't know yet if it will replace some of the other strains that have been used for a long time but it certainly is a vigorous thing. In the three or four years we have had it at Beltsville, we have never seen any disease on that grass. It has been grown without any artificial water. You know that in order to grow bent greens you must have water, but nevertheless we didn't have any. This bent

plug was set there and it covered an area of about 1½ feet by the end of the season. It had beaten crabgrass during the summer season when crabgrass is at its best.

This is a picture of some of our experimental plots at Beltsville. We have tried in the last few years to grow combinations of cool season and warm season grasses so that we could keep the ground covered with some grass that was growing at all seasons of the year. Our thought was that if we could keep some grass actively growing at all seasons that the growth and competition for nutrients and moisture and so forth wouldn't afford the weeds much of a chance. We have a zoysia base in this turf. The picture was taken during the winter months when the zoysia is dormant and off color. We have other grasses over-seeded. The best strip is right through the center. It is Merion bluegrass. That plot never gets any chemical treatment of any kind. It gets fertilized but it doesn't get any water. We just mow it and feed it. I doubt if you could find a better piece of turf any place than we have on those plots. We think the day is coming when we will be growing combination turf in other sections of the country.

This is a picture that was taken on Dr. Grau's lawn during the winter months. This is U-3 bermuda. Some of you might wonder how to choose between crabgrass and bermuda. They are both brown in the winter time and are both nice and green in the summer. As a matter of fact, we are often asked that question. Look at the way the golf ball sits up on the bermudagrass. The U-3 does well in our area. It will keep you out of the mud even when it is dormant. Crabgrass disintegrates during the winter and no turf is left. U-3 bermuda is a pretty good crabgrass control as far as we are concerned.

You have heard height of cut discussed. Yesterday Dr. Sprague was talking about the height of mowing on grasses as it effected the root system. Height of mowing in the case of some grasses has an effect on the way they are able to compete with crabgrass. These are some of our experimental plots at Beltsville. This area was clipped at a height of two inches. This one here at the height of four inches. There are ten foot strips of a number of different grasses. You can see that some of those grasses were not able to compete with crabgrass no matter what height we cut them. The crabgrass came in and took over. Others of these grasses such as the fescues when cut at four inches

will compete with crabgrass. When we cut them at two inches or shorter, the crabgrass pretty well took over during the summer months. This isn't true of all the grasses. I think bermudagrass can be cut much shorter than two inches and if it is properly fertilized, it can still compete with crabgrass. In the case of some of these other grasses that you might attempt to use, height of mowing might be a factor. I don't believe it is as much of a factor in the south as it is up in our area.

We mentioned this matter of good insect control as being a factor in weed control. In 1941 the Japanese beetle around Washington and Baltimore was bad. The grubs just practically ate the turf. You could pick the grass up out of the ground. There just wasn't anything holding it down. These three strips were plots in which arsenic had been applied to control the Jap beetle grub. The grubs were not able to operate well in there with the arsenic and the bluegrass was growing throughout the summer. In the other areas where the Jap beetle had not been controlled, the bluegrass turf was eaten up. The crabgrass came in and took over. This was what was left that winter of 1941.

I think a lot of you might recognize dallisgrass. The picture was taken at Memphis Country Club. Dallisgrass is one of those things that seems to be rather difficult to control with any kind of chemical. There does not seem to be much selectivity between the dallisgrass and the bermudagrass. I heard somebody say the other day that they had very good luck with some of the oils. I have seen some oil sprays used, especially in spot treatments. The ones that I have seen didn't appear to be very selective. They did kill the dallisgrass but they also had some bad effects on the bermuda. The next picture shows one way of getting rid of dallisgrass. That picture was taken in Texas. It is a fairway after dallisgrass had been weeded out with a hoe and it certainly isn't a very pretty sight.

This is a dallisgrass cutter. It is nothing more than a series of straight disks. The machine was developed by Mr. Jimmy Hamner at Memphis Country Club. It is a vertical mower, you might say. If you drag that thing over the fairways, it will do some damage to the bermudagrass, but the damage is not serious. It will heal up very quickly. If you cut those dallisgrass branches off, you aren't going to have much plant left. If you can follow the practice of running a machine similar to this over those crabgrass or dal-

lisgrass areas two or three times during the season, we believe you would do a lot toward reducing the stand of weedy grasses that you have. This is just another view of the same machine showing it from the front.

Here is another device that some people have used in combating crabgrass. It is two Del Monte rakes hooked up on a little tractor. Those rakes are able to pull up the crabgrass stolons so that the mower can cut them off. This is not complete control but nevertheless it will keep those spreading branches of the crabgrass from growing out and smothering the turf.

This is an apparatus called the Flexi-comb. It is hooked onto the front of the fairway unit of mowers. The springs of that comb do just about the same thing as the Del Monte rake. They rake up the crabgrass branches so the mower can cut them off. You keep the crabgrass from going to seed and eventually, if such a practice is followed long enough, we think you will certainly make a reduction in the crabgrass population. Last summer at the Fairfax Country Club this device was used a good part of the summer. If you had gone out there, you would have thought Mr. Glover at Fairfax never had any crabgrass in his fairways. He simply kept it under control by this mechanical method.

Sodium arsenite is one of the oldest crabgrass control materials we have used. I think Dr. Grau first started using sodium arsenite in connection with some of his studies at the University of Maryland in about 1931. Sodium arsenite has been a very good material but it is one of those things that require careful handling. It is poisonous and hasn't found much favor with the home owner. Nevertheless it is still a good material and on bermudagrass you can get excellent results with it. This picture was taken on the football field at the Naval Academy at Annapolis. This is bermudagrass and this is crabgrass. We got enough arsenic on there to give the crabgrass a terrific burn but the bermudagrass is hardly hurt. I believe that you fellows probably are going to continue to use sodium arsenite for some time to come. There are other newer materials on the market and some of them might replace sodium arsenite to some extent, but on bermudagrass turf it is still one of the very best chemicals that you can use for crabgrass control.

Sodium arsenite can get you in trouble sometimes. This picture was taken at Philadelphia. This is a patch of

bent and the soil is dry. That is something you should remember about sodium arsenite. Use it when the soil is moist and the grass blades are dry. If you have moisture in the soil so that the roots can take up moisture, then you won't get into so much trouble. If you treat the turf when the soil is dry, you are very apt to get a severe burn.

We talked about one of the very oldest crabgrass control chemicals, now here is one of the very newest ones. This material wasn't developed primarily as a crabgrass control material but it was soon speculated that it might be good for crabgrass control. It is maleic hydrazide. You may have seen it advertised as a material which you could spray on hedges or on grass and you would never have to clip the hedge any more or never have to mow the grass any more. Maleic hydrazide was supposed to stop any plant from growing but it wasn't supposed to do any damage to the plant. It sounded awfully good but I don't think anybody threw away their lawn mower. Here is a series of plots on Zoysia Japonica. This was the untreated plot and these are the treated plots. We stopped the grass from growing and didn't have to mow it any more the rest of the summer. I don't think you would want that kind of fairway. This picture was taken two months after the treatment was made. The grass was very severely injured. As a matter of fact, 90% of the zoysia was killed completely on these plots.

The next picture is the same sort of treatment on a bluegrass lawn. This was taken very shortly after treatment but the same story was true here. We nearly killed out the bluegrass in July with this maleic hydrazide treatment. The crabgrass came up later and wasn't hindered very much and it made a pretty good stand. So I guess we can discard that one.

There are a number of newer materials on the market for crabgrass control. Among these are the phenyl mercury compounds, which are commonly known as the PMA materials. They have been tested for about three years and in order to get the testing job done a little faster, the manufacturer of one product containing PMA has taken it to South America for a few years for testing during their summer. I think they consider that they now have about five years test on the phenyl mercury materials. They are found to be quite effective on crabgrass in early spring. If you treat the crabgrass when it is in the two or three leaf stages, the phenyl mercury materials do a very good job. They can be used with relative safety on greens. As a mat-

ter of fact, they are fungicides as well as weed control materials. If they are used in the spring of the year, perhaps you can control some diseases at the same time you are controlling crabgrass. On the other hand, we have better fungicides than the PMA products.

Phenyl mercury materials are rather expensive, probably so expensive that you wouldn't want to use them on fairways or other large turf areas. I don't know just what the cost would be but it is relatively high. They are poisonous. You must be careful in handling them. I don't think that should be a particularly serious drawback to you fellows who are in the habit of handling poisonous materials. You know how to handle them and you will be careful with them. However, in the case of home owners, they should be cautioned in handling phenyl mercury materials. We have had some reports that these materials may have some harmful effects on the root systems of grasses especially on greens where a lot of times the roots might be shallow anyway. We don't know just how much basis in fact these reports might have but if you are going to use the materials, you should watch for such effects. If you think you are damaging your roots, you had better lay off.

Potassium cyanate is another one of the newer materials. It is still newer than the phenyl mercuries. It is not a new material but it is new insofar as its use for crabgrass is concerned. Potassium cyanate seems to do a better job later in the season (just about the time crabgrass is beginning to show up those first seed heads.). If you get an application on about that time, you will probably have pretty good luck. There has been a lot of study this past season on gallonage, how many gallons of water to use, what rate of potassium cyanate to use and whether you should use a wetting agent or not. A lot of these things require more study. We have some indication that about 200 gallons of water to the acre is the right amount to use and about eight pounds of potassium cyanate to the acre with a wetting agent of some sort. Such things as Dreft and Glim (ordinary detergents) have been used. They can be mixed with the KOCN and water and will serve as a wetting agent. There are other materials on the market formulated in such a way that they have the wetting agent included with the compounds. The wetting agents do seem to do a good job of increasing the effectiveness of potassium cyanate.

Potassium cyanate has several good features. It is relatively non-poisonous. I don't recommend salting

your dinner with it or anything like that, but nevertheless it is really not so poisonous as some of these other materials. It is a relatively cheap material. I don't know the cost exactly but it is cheaper than a lot of the other crabgrass materials. It is not one to leave a harmful residue when it breaks down. As a matter of fact, some people have said that they actually got stimulation of the grass after the potassium cyanate broke down. I don't see that there is enough nutrient material applied to provide much stimulation of grass but maybe in killing out the crabgrass and reducing the competition, stimulating effects were produced.

We have already talked about sodium arsenite a little bit but I want to say a few more words about it. Sodium arsenite formerly has been used at rather heavy rates. Whenever we used it, we got a rather severe burn. We had to be careful in using it on bluegrass or bents. This last year there has been considerable experimental work done using much lighter rates. It has been used at rates as low as one pound of sodium arsenite to the acre. That is a very small amount but when used in the spring and with a wetting agent, it appears that fairly good results can be obtained by using those very light rates. I think we need to know more about the effectiveness of sodium arsenite used at these rates, especially in the south where we have a lot of bermudagrass. Bermudagrass is fairly tolerant of sodium arsenite and I believe we can get much more selectivity than we have in the past. There are numerous other compounds that have been tested to some extent for crabrass control.

Sodium chlorate is a specific for crabgrass control. Dr. Grau worked with that back in the 1930's. It is an excellent material. It has the disadvantage of being a fire hazard. A lot of people just won't use it. I don't know just how dangerous it is, but there have been some accidents with it and certainly it isn't the kind of thing you would want to recommend to a home owner as long as it is a serious fire hazard.

Various petroleum fractions have been used. Michigan State College has tested a few petroleum fractions for three or four years. They have reported fairly good results but the tests of other stations indicate that petroleum fractions haven't behaved nearly so well as they did at Michigan College.

Sodium fluorsilicate has been mentioned as a crabgrass control material. It is an insecticide but there is

considerable evidence that it may have some value as a crabgrass control material. I would like to see some further testing done with this material. It may be that it will be a good, cheap crabgrass control material.

That is about the list of things that have been used on crabgrass. There have been numbers of other chemicals tried from time to time but these are the ones that have received some consideration as being potentially useful for crabgrass control. The past year there were crabgrass trials in many sections of the country. As I said, there seems to be a frantic search for some chemical that will easily and effectively control crabgrass.

The Green Section in the coming year would like to recommend that some kind of coordinated national crabgrass control trials be conducted. The American Phytopathological Society for the last few years has conducted what they call National Cooperative Fungicide Trials. The system has worked out very well. A coordinator is appointed and he sees that every experiment station who is interested in carrying on some such trials gets chemicals from a certain lot that is prepared by a fungicide manufacturer. Those chemicals will be distributed so that everybody gets fungicides from the same lot. They know that they have uniform materials. They all put them out at certain rates and they report to the coordinator at the end of the year and he is able then to summarize the data. We have gotten some rather interesting and very good information on the use of fungicides. If we could do a similar thing for crabgrass control materials, I believe we might get further. As it is, each experiment station has laid out its own plots and has collected data on crabgrass control materials. There has been some duplication of effort but the tests have not been conducted in a uniform manner and therefore it has been impossible to use one station's results as a check on another stations results. We believe national cooperative crabgrass control trials could be instituted and we think we might get some valuable information. The experiment stations now are being circularized to see how many of them would subscribe to that kind of testing program, and to determine whom they would like to elect to carry on that work and to serve as coordinator. I am sure the Texas station will get one of these letters and if you are interested in doing some cooperative work, we will be interested in your reaction. Give us your thoughts on the matter even if you are not in a position to take part in the trials.

USE OF METHYL BROMIDE FOR CONTROL OF UNDESIRABLE VEGETATION

Ralph Rowley
Goldthwaite's Texas Toro Company

Methyl Bromide more or less slipped in the back door as a weed and grass control chemical. Methyl Bromide has been used for years as a fumigant. Its ability to penetrate quickly through multiple layers of paper, or other packaging to the center of a package, killing all forms of life, whether active, dormant, or in the egg stage, and as quickly to leave the package on aeration without contaminating the contents, makes Methyl Bromide outstanding in the fumigant field.

These same properties introduced Methyl Bromide to the soil fumigation field for control of soil-born or inhabiting insects, especially in specialized areas such as seed beds and nurseries. Delays in planting after fumigating, as is the case with most other soil fumigants because of slow aeration, cost of grower time and money, were eliminated with Methyl Bromide. Also, it was very quickly noted that all weeds and grass in treated areas were killed and that treated beds stayed clear of unwanted growth, showing that all seeds and stolons present prior to fumigation were killed by the fumigant. This back door entrance as a weed control chemical saved growers costly hours of hand weeding and also introduced Methyl Bromide to the turf field.

A new green is a seedbed and undesirable grasses are weeds. A quick, easy efficient method o' eliminating all grasses and seed from an area before planting the desired species of grass saves hours and dollars in blocking out the undesirable species. The same applies to top dressing-- why add undesirable grasses or seeds to an area? The elimination of undesired species of grass from areas of established turf such as bermuda encroaching on bentgrass greens, coarse bermuda encroaching on a fine bermuda green, or nut grass growing and taking over in grass areas or traps, all have been done successfully and in most cases more cheaply, efficiently and in less time than with other methods.

Right here, if I may, I desire to change my nomenclature to the actual product used for this work-- Dowfume Mc-2. Dowfume MC-2 is a trade name for a specific product put out by one manufacturer but because Methyl Bromide is a highly toxic, quick acting gas that is

colorless, odorless and tasteless, the Dow Chemical Company considered it very advisable for safety's sake to market a material to a trade that is not especially versed in handling a poisonous gas. They market Methyl bromide with a warning agent. Dowfume MC-2 is 98% Methyl bromide and 2% Chloropicrin. The Chloropicrin-- tear gas-- is easily and quickly detected and acts as a warning agent to users in case of accidental leaks or dangerous concentrations of gas. Also to my knowledge all actual turf field work has been done using Dowfume MC-2.

The necessary materials for actual MC-2 work are few and inexpensive.

1. A methyl bromide tight cover. Since methyl bromide will very quickly penetrate papar or cloth only specially treated paper or cloth or certain plastics can be used as covers. Cost 1-3/4¢ to 2¢ per square foot and may be used repeatedly.

2. Methyl bromide applicator. Cost $4 each and only one is necessary regardless of the size of the job, however, two or three speed up the work if large areas are to be treated. These applicators may be used indefinitely.

3. Saran or copper gas tubes. Cost $2 each and size of job determines the number necessary-- usually 4 if considerable work is to be done and they may be used over and over.

4. Dowfume MC-2 is available in 1 pound cans. Cost is 85¢ per pound and one pound will treat 100 square feet.

Other materials can usually be picked up around any shop or golf course.

The use of Dowfume MC-2 is quite simple and easy. Three steps cover the whole operation:

1. Placing a methyl bromide tight cover over the area to be treated.

2. Applying the gas under the cover.

3. Removing the cover.

The first step-- placing a methyl bromide tight cover over the area to be treated, is the most work and probably the most important. A support should be

placed along the center of the area to be treated. This support should be 8 to 12 inches high, so that there will be a tent effect when the cover is spread over the area and may be anything such as boxes, large cans or a built support made by driving stakes into the ground and nailing a 2 inch or 4 inch strip along the top of the stakes. Rough edges or corners should be covered with a burlap sack or some other material to protect the cover. A gas pan or trough should be placed at 25 or 30 foot intervals along the center support and one end of the gas tube anchored in the pan. The gas pan may be a piece of eaves troughing or a similar material and is used to hold the liquid MC-2 until it vaporizes. If the liquid MC-2 is allowed to pour onto the ground, the immediate area tends to hold the gas and not let it distribute evenly over the whole area. The free end of the gas tube should extend from under the cover so that the applicator can be attached. After the center supports, gas pans and tubes are in place, the cover is unrolled over the area first sealing one end and working downwind, if possible. The tubes should extend from under the cover on the up wind side, if possible. The outer edges of the cover should be covered with soil from the adjoining area as the cover is unrolled to prevent wind from blowing and damaging the cover. After the cover is in place, the soil on the outer edges [illegible] securely by tamping or other means. If the soil is dry, light sprinkling before packing will make a better seal. Water is one of the best sealing materials for methyl bromide.

Secondly, the cover is in place and inspected to be sure all is in good order. We are now ready for the gas. The applicators are attached to the gas tubes being sure the tubes are open first by blowing through them. Do not try to suck air through the tube, since traces of gas may still be in them. The cans are then placed in the applicator and emptied, one following another until the correct number of cans has been used. The last can should be left in the applicator as a seal until the gas tube is removed or until cover is removed. The gas tube may be removed by pulling, holding the dirt seal in place lightly and packing securely after removing the tube if additional areas are to be fumigated before the cover is removed. Now a 24 hour fumigation period.

The third step-- removing the cover-- only calls for a few comments on caution to protect the cover and the persons doing the work. Since the concentration of gas under the paper is still quite high, if the job

was properly carried out, care should be used in releasing this gas to the atmosphere. A samll portion of the dirt seal-- three to four feet-- should be removed from the corner thrown back to allow the gas to escape. Now, remove the dirt seal from a similar portion of the cover which is most up wind and turn back this corner. With the diagonal corners raised, the wind can sweep most of the remaining gas from under the cover. Allow at least thirty minutes for the high gas concentration to escape and then remove the balance of the dirt seal and reroll the paper, working up wind. Always remember the cover is expensive and can be used over and over if not damaged. After a 24 hour aeration period, seed may be planted and stolons or plants set out after 48 hours.

Dowfume MC-2 should be used for weed and grass control at the rate of 1 pound to every 100 square feet of area under the cover. For 500 square feet use five pounds and for 870 square feet use nine pounds. In other words, it is better to be safe and not under treat. Over treating does not harm the soil. The work should be done with temperatures above 70° F., how, ever, considerable successful work has been done with air temperatures as low as 50° F. but in all probability the soil temperature was near 70° F. If the temperature is low, the cans of MC-2 should be heated in warm water for 30 to 40 minutes before using. Wires or heavy cords may be attached to sections of the cover supports, the gas troughs, etc., so they can be pulled from under the cover thereby allowing it to lie flat on the ground and facilitate rolling it after the fumigation period. Always set cover on fairly level contour--methyl bromide is slightly heavier than air and tends to seek low areas if allowed, thereby leaving any high area under treated.

In treating large areas such as golf green seed beds, I suggest that alternate strips be treated on successive days. The inbetween strips can be covered by moving a complete set-up over to cover the untreated strip. Care should be taken to lap over into the treated area at each move to insure that no untreated soil will be left in the seed bed at the end of the treatment. If the job is one of stripping around a green or grass area to kill undesirable grasses, slightly moist top dressing mixtures make an excellent material for sealing the edges of the cover. This material can be raked over the treated area after the cover is removed and will help hold the seed. The dead grass need not be removed. Before seeding a good stiff raking will help produce a very good seed bed.

The grass mat helps hold the seed where they are sown and affords some protection for young seedlings. Seed should be sown in areas as soon as possible after treatment to take advantage of the dead grass stubble.

As a summary, I would state again the three steps in treating:

1. Place the gas tight cover.

2. Shoot the gas-- one pound to every 100 square feet--under the cover and leave for 24 hours.

3. Remove the cover and allow a 24 hour aeration period, then sow seed if area is to be re-planted.

I would also like to offer the following list of precautions:

1. Treat methyl bromide or MC-2 with respect--it is a poison gas.

2. Work outside always and upwind if possible.

3. Place danger or poison gas signs on cover if area is subject to traffic.

4. In cases of leaking or broken hose, bad puncture in can or any other spilling of MC-2, let can empty, holding it so gas will blow down wind until can is empty. Do not try to repair leak or save gas. MC-2 is cheap; a life is not.

5. If MC-2 liquid is accidentally spilled on clothing or shoes, remove at once and air thoroughly before wearing again.

6. Do not wear gloves. MC-2 will not burn if spilled on bare skin but if spilled on clothing gloves or shoes, it can burn seriously.