PROCEEDINGS

OF THE

EIGHTH ANNUAL TEXAS TURFGRASS CONFERENCE

A & M COLLEGE OF TEXAS
COLLEGE STATION, TEXAS

JANUARY 18-19-20
1954

This Conference has been made possible through the joint efforts of the Agronomy Department - Texas A & M College, The Texas Turfgrass Association and The Green Section of the United States Golf Association.

June 10, 1954

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THE COST OF WATERING TURF GRASSES

John H. Ruhmann

It is a pleasure to again talk to the Texas Turf Association on the problem of "Turf Grasses" and "water" in our complex city life. I consider it a privilege to present to you a few facts and generalities denoting the importance of turfgrasses and what it costs us to produce them. I regret that I could not attend this meeting to personally discuss this matter.

There are new frontiers being opened almost every day. Take for instance the field of medicine. Today we still see our people dying from cancer. But it is a frontier; we are making efforts to find the cure; we believe it can be cured. Yesterday we took it for granted that cancer was incurable and did nothing; tomorrow the cure will probably be found and we will wonder why it wasn't found sooner. To bring the idea closer to home we can turn our attention to range grasses. A few years back we took range grasses for granted; we accepted as a fact that since nature had provided good range in the beginning no effort on our part would be required to improve them. Today we know this isn't true. We are improving range grasses.

I am simply trying to bring you to this point as a beginning: That effort on our part will improve turfgrasses.

Now that effort required to improve our turfgrasses will be personal and economic and must be justified. It must be justified to each of you personally before you will make the necessary effort as individuals and it must be justified as important to the public before economic aid will be forthcoming.

Economic aid brings us to the crux of the discussion, namely: What do turfgrasses in the city cost?

In West Texas where turfgrasses are much more important than they are in many other places due to soil erosion, they cost considerable time, effort and money. Yet we must have them to protect us from soil erosion. During periods of drought it is many times necessary to let the grass die. Not, however, because we are not willing to pay a reasonable price for the water to keep the grass going, but because we can't get it at a reasonable price. At this point we come to the challenge for Turf experts: Grasses more resistant to droughts and a program of education designed to teach the public how to care for turfgrasses during periods of low rainfall at a cost which is as reasonable as possible.

In order to more closely approach the effort required for turfgrasses we might look at some hypothetical estimates.

For instance, suppose we consider a lot owner whose lot is 60 feet by 125 feet. This lot is in a city of 100,000 people and would represent the medium or low medium income. During one of our West Texas droughts this lot owner would work hard two hours a day in the summer to keep his yard looking presentable. During these two hours he will probably operate one and one-half (as an average) sprinklers which flow from 3 to 12 GPM at a total overall water cost of $15.00 per month.

If, through your efforts, you can develop a turfgrass which will require one-half of this watering time and educate the public to use it, the saving would be very impressive. This saving would amount to an estimated $72.00 in labor and $11.25 in water, per year, per lot. This $83.25 saving, per average lot owners, per year, will justify to the public a reasonable expenditure to develop better turfgrasses.

Our rationing program has been necessitated by the drought and deficiencies in our water system. It has been planned to give the shrubs and grass a reasonable, limited amount of water without exhausting our supply.

In West Texas where rainfall is limited a Water Engineer sometimes wonders whether we can ever provide in a growing city all of the water during dry summers which would be used on grasses. And even where you can, the production cost of quantities required is prohibitive to a large part of our population.

As Water Engineers deal primarily in water consumption figures and cost rates, both of which incidentally are almost as unpleasant as taxes, you might be interested in some approximations on the cost and use of water in connection with grasses here. With these figures you will be able to judge how important it is from a water economic basis to have grasses that require as little water as possible and those that we know how and when to water.

For instance, on the basis of our city, we used last summer during August, 23 million gallons of water on the maximum day during August. We were rationing water at the time and probably would have used 27 or 28 million without restraint. However, for estimation purposes we will say that our maximum day last summer was 24 million gallons. This summer we have determined our domestic, commercial, industrial, and air conditioning load at 12 million gallons per day or slightly less. This leaves a remainder of 12 million gallons per day which goes on shrubs and grasses. If we assume that a third of this water went on shrubs which I believe is a little high--we have a remainder of eight million gallons a day going on grass. That would mean that one-third of our water investment is fixed for grass. Our plant is worth, on a replacement basis, about 15 million dollars, so we can say that approximately five million of our investment is for turfgrasses.

If we look at some comparative consumption figures we can see what is happening. An average water plant might be designed to provide an average family of 3½ people with about 910 gallons of water for average daily use. And yet that family with a fairly good income will use water at ten times that amount during a dry summer.

Again, this is only two sprinklers operating on a three gallon per minute basis. This is actually very low when you consider that yard sprinklers will operate at a rate of from 3 to 12 gallons per minute and that ordinary park sprinklers operate at a 17 gallon per minute rate.

As we are doing in the West Texas range grasses we must do in the turfgrasses; that is, produce better grass with less water. That is a big order but no doubt Turf Specialists can greatly improve our situation. Water Engineers and the people must look to Turf Specialists for improvement in this problem because it is doubtful whether there will ever be enough money to provide for turfgrasses alone all of the water that could be used.

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WATER REQUIREMENTS OF TURFGRASSES

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A consideration of water requirements of turfgrasses is a good place to begin one's thinking about turf irrigation. Rather than use this rather confusing term, "water requirement", which unfortunately has been given more than one meaning, let's simply talk about the "water use rate". By this we mean how much water is needed per day to compensate for that lost to the atmosphere. Irrigators usually express water use rates in inches per day. A use rate of .20 inch per day means that the equivalent of a water layer 1/5-inch deep has been lost during a 24 hour period from the soil and plant to the air above.

The water use rate, or the amount of water needed each day, depends primarily upon weather conditions -- particularly sunlight intensity, temperature, humidity, and wind. Trees and shrubs may compete with the grass for water and increase the rate at which water is extracted from the soil. The rate of water use differs somewhat from day to day and, of course, especially from season to season. Water use also varies from place to place, and even on a single piece of turf, water consumption may vary considerably according to exposure.

Little information based on direct measurements is available on water use rates for turfgrasses. Fortunately the rate of water use by turf is very nearly equal to that by pasture grasses and alfalfa for which data are available in some areas. Where no water use data are available, approximate values can be calculated from meteorological measurements. While I won't trouble you with how such approximate water use rates are determined, I do wish to stress that information on water use rates in your locality for different seasons is important if you are to plan wisely your irrigation program.

What are some fairly typical values for water use rates? While talking to Dr. Lemon in order to get a little Texas data into this story, he told me that out in the Plainview and Big Spring areas his studies indicate that the water use rate may approximate .20-inch per day. Here at College Station, again based on calculated values, the use rate according to Dr. Lemon for May topped .17-inch per day, June about .20, July .23, and August .23 to .25. Then in September it drops off again to about .20-inch per day. These values are for just two localities here in Texas. I don't have information for other spots in Texas, but I do have a little California data which can be used to illustrate the range of water use rates found in other climates.

In the dry desert areas, the use rate can be as high as about .35-inch per day. In California's interior valley, where it is hot and dry, water use runs from .30 inch per day in the southern part of the valley to about .25 in the northern part. In the coastal valleys where the temperatures are lower and the humidity is higher, use rates run about .20 inch per day. Where there is considerable coastal fog, it drops down to about .10-inch per day. These simply show you the range in water use with which we may have to deal in planning irrigation systems. If we take a mean use rate of .25-inch per day, a value fairly typical of summer months here at College Station, what does this mean in terms more common to us? At this rate, 156 gallons per 1,000 square feet or nearly 7,000 gallons per acre are consumed per day. These are approximate figures, but they do give us something to tie onto if we are planning a water supply or checking on the water that is being delivered to us.

Getting back to the practical problem of turf irrigation, water use data provides a sound basis for planning an irrigation system. Such information tells us the amount of water which must be supplied either by rain, withdrawn from the soil moisture stored within the root zone, or supplied by irrigation. I have been told that irrigation systems for golf courses and parks in this area are designed to supply .25-inch per day.

This would seem to be a reasonable figure for this area on the basis of the limited data now available. Just because the sprinkler systems may be designed to deliver .25-inch per day, or .50 inch every two days, it doesn't mean that we should always apply this much. Whenever summer rains occur, they reduce the quantity of water which must be supplied by irrigation. According to Weather Bureau records, at College Station you can expect to get somewhere between two and three inches per month during the summer. Comparing this rainfall against the expected use of .25-inch per day or 7.5 inches per month, we see that irrigation will on the average need to supply only about two-thirds of the daily water used by the grass or somewhere around .16 inches.

In considering irrigation, we have to look at these questions. Does the grass really need water? And if so, how much should we apply? Here we have the two basic irrigation questions. These questions must be answered every day by the men with the hose and sprinklers. The wisdom of their decisions largely determines the quantity of water need, the application costs and the quality of the turf directly or indirectly through the effects of water on disease, weeds, and soil compaction. While I suppose one risks the danger of stepping on some tender toew, I velieve it is correct to say that turf is probably the most poorly irrigated "crop". I say this to arouse us a little bit and to cause us to take another look at what we are doing. If we are to learn to save water and save money in turf irrigation, we must recognize that turf irrigation habits are often bad habits from the stand-point of the soil characteristics and the needs of the grass for water. Irrigation practices unfortunately are usually set by habit, by the calendar, or by what we are told may be the special requirements imposed by the use for which the grass is grown. Let us forget for a few minutes our habits and these special demands which are often saddled on us. Let's look at irrigation solely in terms of soil moisture characteristics and the need of the grass for water. It is true some think that the answer to how to irrigate is simply to turn on the valve. It's like the man of few words who strolled into a barber shop and when settled down in the barber's chair was asked, "How would you like your hair cut?" "Off," was his simple answer. That simple answer expressed what the customer wanted, but the barber must face the practical problem of how the hair was to be taken off. And so in irrigation, unfortunately, sometimes we concern ourselves only with where the valve is located and worry little about how the job is to be done.

When to irrigate? Irrigation is needed only when the grass is about to run out of water. How much water to apply? The amount to apply is that which has been removed from the soil. The experienced irrigator tries in general to "connect the moistures". If after an irrigation there is still some dry soil between the depth wet and the depth where the moisture is again encountered, the irrigator hasn't "connected the moisture". If this is repeated frequently, he runs the risk of gradually losing the deep roots of his grass. There is no substitute for looking below the surface of the ground in irrigation. It is difficult, in fact impossible, to irrigate well by always looking only at the surface. The use of a soil tube is an essential part of good irrigation management.

Before going on, I'd like to take a few minutes to refresh our memories about the water retention characteristics of soils. This can be done conveniently by rolling out the well-known "barrel" illustration. Picture a barrel with a closed tap on the side and a leak about midway up the barrel. If water is added to the barrel quickly, the water level will rise to the top occupying all the space in the barrel. This corresponds to a "saturated" soil in which all the pores are filled with water to the exclusion of oxygen -- a very unfavorable condition for root growth. If no more water is added to the barrel, water will seep away (through the leak) until drainage ceases. Although a portion of a normal well-drained soil may be nearly saturated for a short time following irrigation, 1/3 to 1/2 of this water soon drains away, and the soil reaches a characteristic moisture content called the "field capacity". Returning to the barrel illustration the thirsty drinker can draw water by opening the tap, draining it only down to the level of the tap. Likewise the plant can extract water from the soil only down to a certain level after which the plant wilts, and the soil is said to be at the "wilting point". The quantity of water held between the field capacity and the wilting point is called the "readily available water".

With this brief review of soil moisture characteristics, let's again consider the question of how much water to apply during an irrigation. If the soil has been dried out until the grass begins to show some wilting (approximate wilting point), then the amounts of water which must soak into typical soils to wet them to certain depths are given in the chart of figure 1. For example, to wet a two-foot depth requires $1\frac{1}{2}$ inches of water for sands, 3 inches for loam, and 5 inches for clays. Where surface run-off occurs, the total amount of water applied must exceed the depths of water indicated by figure 1 by that lost in run-off.

<u>Some turf is overwatered</u>. That is, more water is applied and soaks in than the soil will retain within the root zone of the grass. The surplus water drains down through the soil carrying away nutrients and often creates a soggy subsoil and consequently shallow roots.

<u>Some turf is underwatered</u>. That is, less water is applied than is required to wet the soil throughout the depth from which water has been extracted by the grass. In other words, the "moistures are not connected". If, for example, to a loam soil which has been dried out to a depth of one foot, we apply only one half inch of

water, the soil will be wet to the shallow depth of 3 or 4 inches. The soil below will remain dry. Many people are surprised when they learn the amount of water traveler types of sprinklers apply. I understand that they are not used very commonly here, but where they are used few realize what kind of an irrigation job they are doing. If operated in the usual fashion these sprinklers in one pass will apply about one-fourth of an inch of water. Looking back at figure 1, you will note that if one-fourth inch of water is applied to a loam soil which has been dried out to a depth of a foot, the soil would be wet to a depth of just a few inches. If the same quantity of water were applied to a dry clay soil, it would be wet to a depth of only approximately one inch. There is nothing wrong with traveler sprinklers, but they can't give more than a very shallow irrigation on a single pass. What about fixed or quick-coupler sprinklers? You have to take in account its distribution pattern. The typical sprinkler applies more water near the sprinkler and decreasing amounts out to the wetted edge where it applies very little water. In using such sprinklers individually, one should keep this distribution pattern in mind. Normally these sprinklers are spaced to provide overlapping so as to obtain a more nearly uniform coverage over the entire wetted area. You can find out what sort of a pattern is obtained from a single sprinkler or overlapped sprinklers by using small coffee cans and collecting the amount of water that falls along a line out from the sprinkler or running between sprinklers. Any differences in the amount of water collected in the cans will produce corresponding inequalities in the depth of soil wet by the irrigation. This subject is mentioned here primarily for the purpose of stimulating questions for the panel discussions coming during the next few days.

How deep do we have to wet soils? Putting it another way, how deep will soils be dried out by turfgrasses? In general grass roots are most closely spaced near the surface and become more and more sparse with increasing depth. At Davis, we have been studying the rooting characteristics of turfgrasses by growing the various grasses on a deep clay soil. After the grasses have become established, they are irrigated deeply and then allowed to go without rain or irrigation until the grass begins to show a moisture deficit, usually by wilting. Then by detailed soil moisture sampling using a 6-foot tube we found how much of the available moisture has been depleted from the various soil depths. The presence of roots can be inferred by following the disappearance of moisture or determined by direct examination of the soil cores. Under U-3 bermuda, we sometimes find a very thick root sticking out the end of the six-foot sample.

The moisture extraction pattern or the distribution of absorbing roots for U-3 bermuda is given in figure 2. The thoroughness with which the available water has been extracted for any depth is indicated by the length of the moisture depletion bar. At the time these samples were taken, the bermuda had not yet wilted but was growing slowly. Under these conditions most of the available water had been extracted from a depth of about two feet. Below this depth, the amount of water which had been removed diminishes corresponding to the reduction in number of absorbing roots. Notice that under our conditions we find some root activity even at a depth of six feet.

I want to mention briefly the moisture extraction pattern for two bluegrasses to illustrate that by selection or breeding grasses may be developed which have deeper and more effective root systems. Under Davis conditions, Kentucky bluegrass began to wilt when it had extracted all the available moisture from a depth of about 2 feet, but Merion bluegrass in an adjacent plot did not wilt until it had removed all the available moisture from at least a $2\frac{1}{2}$ foot depth. As a result of these deeper roots, Merion was unwilted and looked very good for approximately a week beyond the time Kentucky bluegrass began to show distinct wilting.

The same clipping, fertilization, and irrigation practices were continued on these plots the following year. However, in the summer of 1953 the bluegrasses began to wilt much sooner after irrigation than during the previous summer. It was found that the bluegrasses had lost many of their deep roots so that the effective rooting depths of the then 27-month old stand were only about one-half what they were when 15 months old. The loss of deep roots was most pronounced with the Merion. The dense sod which had formed under the Merion bluegrass may have been at least partially responsible for the death of deep roots. It is interesting that creeping fescues grown under conditions which produced a less dense surface mat showed a much smaller loss of deep roots. No similar loss of deep roots under the bermudas has been detected. Causes for the death of deep roots under some grasses will be explored during the 1954 season to learn whether any management practices can be employed to retain them.

The length of time a turfgrass can go between irrigations without showing moisture stress depends not only on the depth of rooting but also on the water holding characteristics of the soil and on the rate of water use. The chart of figure 3 can be used to predict irrigation intervals. Use of the chart is illustrated by the example given. May I call your attention to the fact that this chart was developed on the basis of an assumed water use rate of one inch per week. If, for example, the use rate in your area is two inches per week, then you can expect the soil moisture supply to be depleted in about half the time indicated on the chart.

Some may be wondering whether the long periods without irrigation suggested by this chart have ever been demonstrated. During the hot summer at Davis, where temperatures run from 90° to 100° F and the humidity less than 20 per cent on most days, the creeping fescues and bent went for 14 days before wilting, Kentucky bluegrass 24 days, and Merion bluegrass (because of deeper roots) about 30 days. However, during the following summer Kentucky and Merion both went for only 12 to 14 days as a result of the loss of deep roots. K-31 fescue, some of which is used in Texas, went for over 30 days. Zoysia did not show wilting for about 45 days. During the next 50 days, the zoysia slowly turned brown but when irrigated turned green again quickly. The bermudagrasses, with roots extending deep in a soil which holds a lot of available water, have gone for as long as 100 days. At the end of this long period without added water, the bermuda was not top quality turf but acceptable for many purposes. This does illustrate that even under high temperatures and low humidities, bermuda can maintain some growth by drawing on moisture supplied by a very deep root system.

This brings us to a consideration of drought tolerance or drought resistance. Without getting into the problem of technical definitions, let's use the term drought tolerance to mean the ability of a grass to go for long periods of time without rain or irrigation by drawing on a large soil moisture reservoir through its deep roots. Drought resistance will be used to refer to the ability of a grass to survive after its available moisture supply has been exhausted. Now if we are interested in keeping a piece of turf in a reasonably green condition, then we are concerned primarily with drought tolerance -- or the ability of grass to go for long periods of time without showing wilting despite the absence of rain or irrigation. The primary measure of drought tolerance is the depth of rooting. Thus one can expect considerable differences in the drought tolerance of bent, bluegrass, K-31 fescue, zoysia, and the bermudas when planted on a deep pervious soil. However, if these grasses are planted on a shallow soil differences in drought tolerance largely disappear. Thus on shallow soils there may be no point in accepting a coarse but deep rooted grass just because of its potentially greater drought tolerance. A shallower rooting grass may stand up nearly as long. Bermuda, zoysia, and K-31 fescue appear to use water more slowly as the available moisture supply nears depletion, so they maintain a fairly green color longer. Thus it is possible to stretch out the water supply by allowing grasses such as zoysia and bermuda to suffer some water deficit over a long period of time. With zoysia the average daily rate of water use calculated over a period of 96 days between irrigations was less than half the rate for the first 45 days. The same sort of thing can be done with other grasses, but the possibilities decrease the shallower the root systems.

The experimental work I have been discussing points out the possibilities of greatly lengthening the irrigation interval in situations where grass roots are deep and soils hold favorable amounts of available water. Less frequent irrigation will, in many cases, permit considerable savings in water and in application costs and often at the same time improve the condition of the grass.

One must remember that the irrigation interval cannot be greatly extended unless the soil moisture removed during the period can be replaced by the next irrigation. Some soils take water so slowly that it is difficult to wet them deeply in a single irrigation. Difficulties in securing deep water penetration under the prevailing soil, slope, and water application conditions will frequently be the limiting factor in extending the irrigation interval. The existance of very real water penetration problems in some situations should not deter us from taking full advantage whereever possible of the potential deep rooting of turfgrasses. Generally one cannot make a sudden change in irrigation frequency. If your grass is shallow rooted as a result of repeated shallow irrigations which leave the subsoil dry, then deeper root growth will have to be encouraged by allowing longer operation periods for the sprinklers in order to supply the needed subsoil moisture. Where the grass has been growing in a soil which has been kept excessively wet, gradually cut back on the amount of water applied allowing the roots to extend slowly into the waterlogged subsoil and to remove the excess moisture. Then with careful irrigation the deeper root system can be retained and a more trouble-free, better turf established.

I would like to stress that a turf irrigator ought to know what conditions exist below the soil surface. He should find out what depth of soil is being dried out between irrigations and then how long he must run his sprinkler system to replace that moisture. Only if one has answers to these questions can turf irrigation be put on a sound basis. This can't be done without using some kind of a sampling tool.

Turf should be irrigated on the basis of soil characteristics and the need of the grass for water. Special demands may at times force us to depart from sound irrigation principles. Whenever this is necessary, let's keep in mind the hazards of what we are doing and return as soon as possible to irrigation practices tuned to soil and plant needs.

The turf research program at Davis is aimed at the development of new information which, we hope, will provide the basis for improved irrigation practices with resultant savings in water and labor costs combined with more easily maintained grass. There is much yet to be learned. From what we now know, may I suggest two simple rules for turf irrigation:

(1) Water deeply -- replace all the moisture extracted.

(2) Water infrequently -- only when the grass needs it.

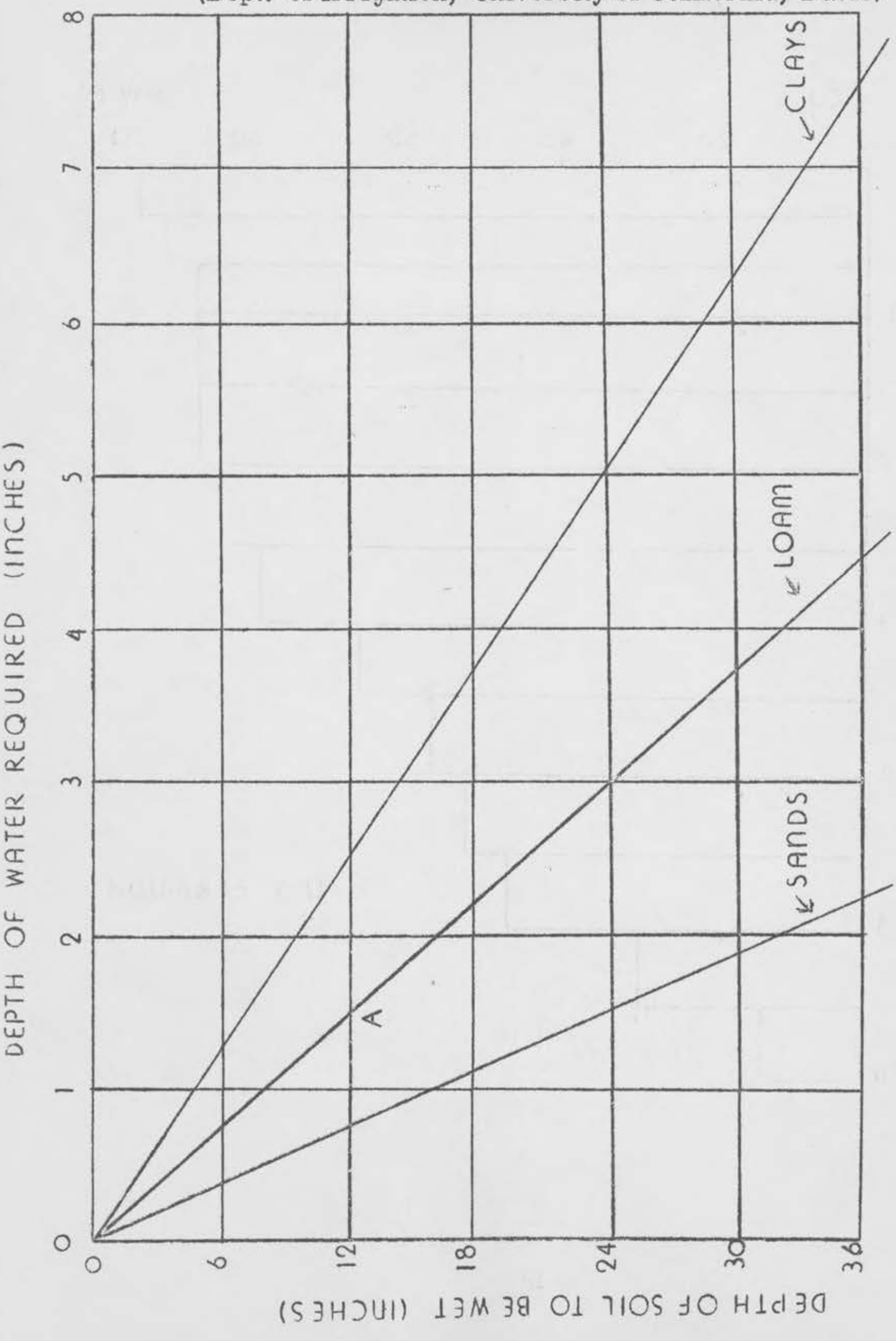
These should be kept before us as general goals. How close you can approach these objectives will, of course, depend on various local conditions.

In closing I would like to repeat something I have said many times before. The curse of irrigated agriculture is often too much water. The curse of turf culture is sometimes too much water, but perhaps as often it is too little water applied too often.

Figure 1.

SURFACE INCHES OF WATER REQUIRED TO WET SOILS TO GIVEN DEPTHS ASSUMING NO SURFACE RUNOFF

(Dept. of Irrigation, University of California, Davis)



HOW TO READ CHART: If a 12-inch depth of loam soil is to be wet, run down left-hand scale to 12-inch line, then across chart to diagonal line labeled "loam" (at point A) and then project line vertically up to scale across top of chart. Depth of water required is 1 1/2 inches.

Figure 2.

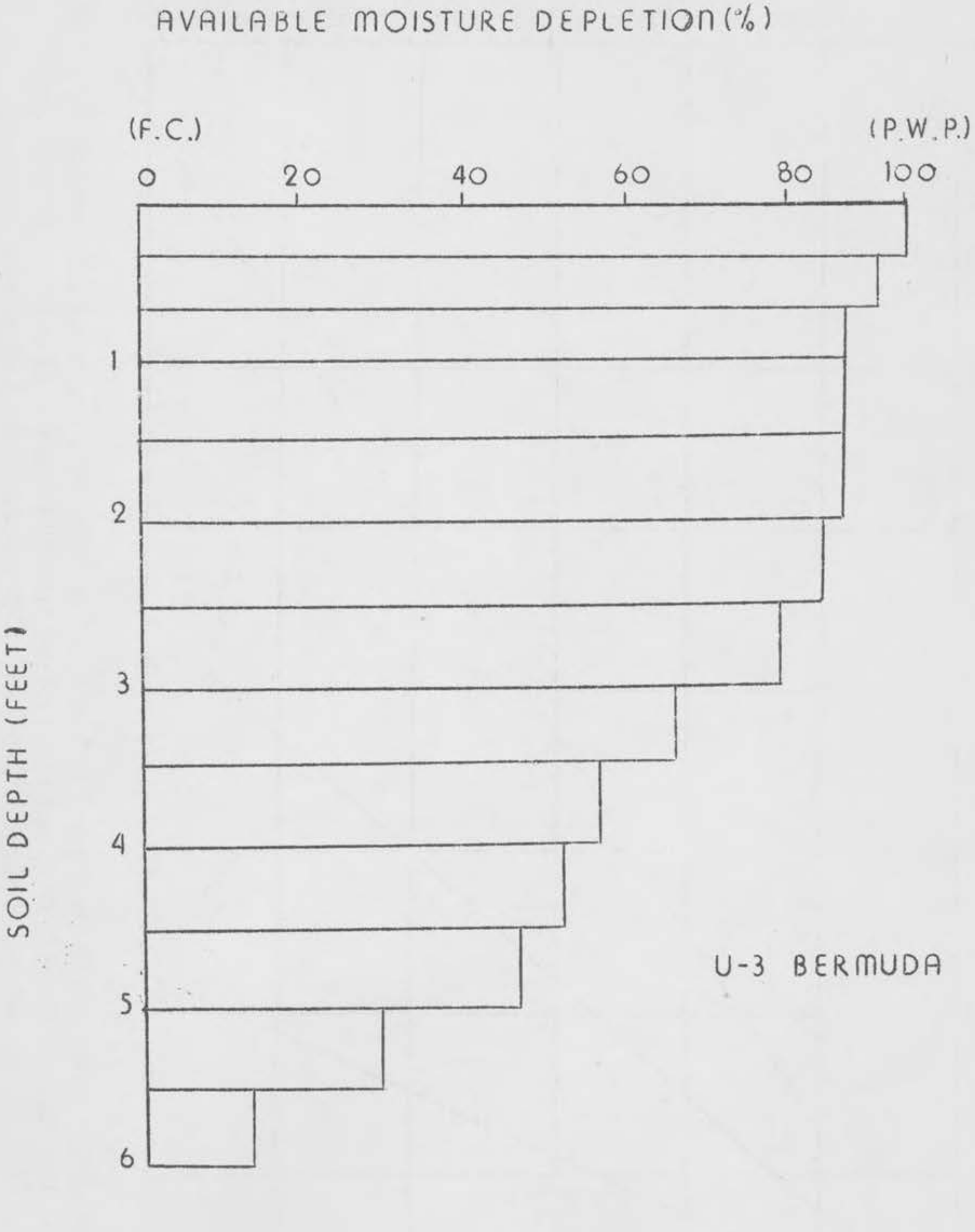
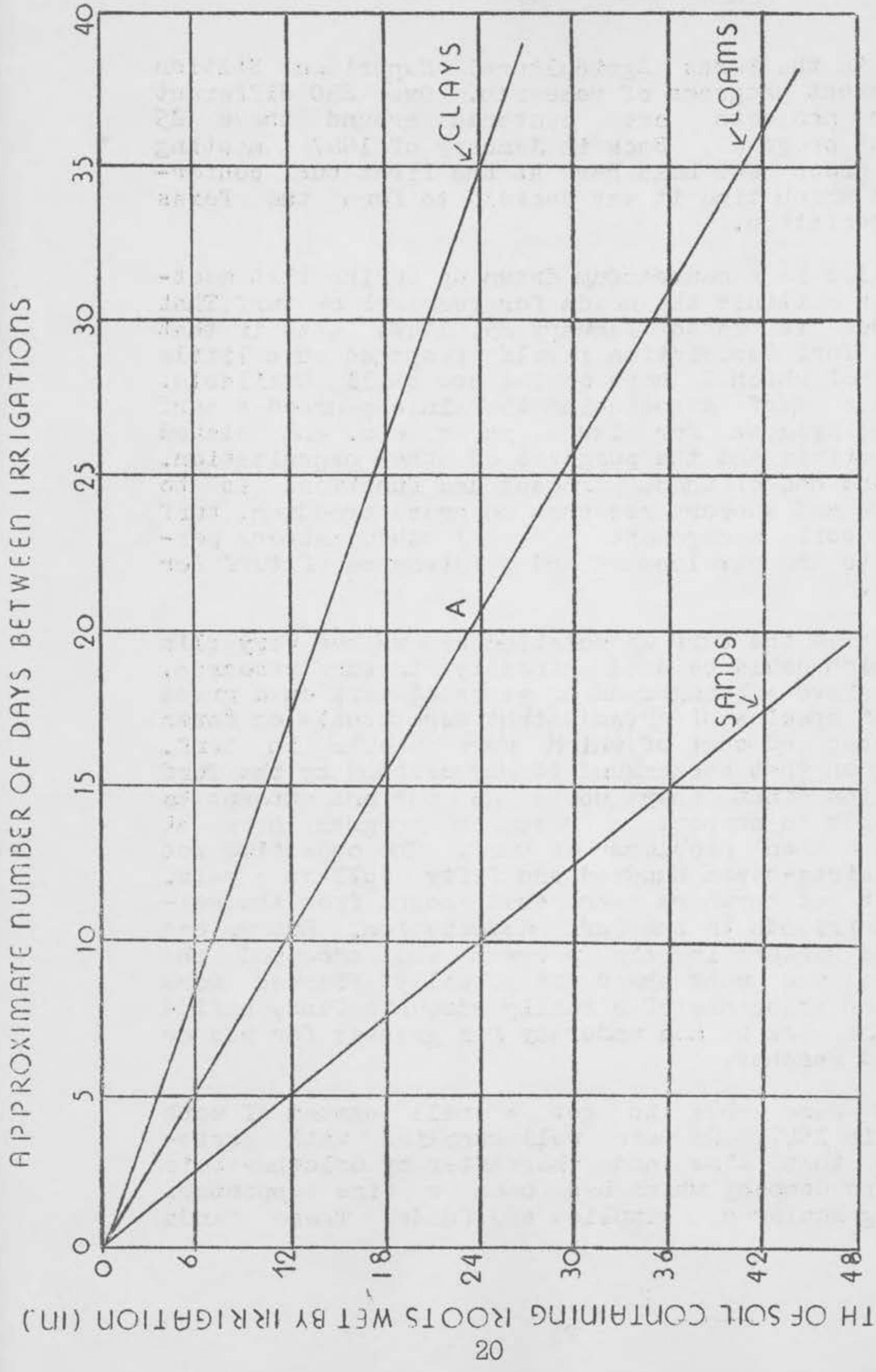

AVAILABLE MOISTURE DEPLETION (%)
(F.C.)
(P.W.P.)
0
20
40
60
80
100
SOIL DEPTH (FEET)
1
2
3
4
5
6
U-3 BERMUDA

Figure 3.

IRRIGATION INTERVAL AS INFLUENCED BY SOIL TEXTURE AND DEPTH OF ROOT ZONE WET WHERE WATER USE IS ONE INCH PER WEEK

(Dept. of Irrigation, University of California, Davis)



HOW TO READ CHART: If grass has effective roots to 24-inch depth and soil is wet to this depth, run down left-hand scale to 24-inch line, then across chart to diagonal line labeled "loam" (at point A), and then project line vertically up to scale across top of chart where you read off about 21 days.

THE DEVELOPMENT OF THE TURF RESEARCH PROGRAM AT THE TEXAS AGRICULTURAL EXPERIMENT STATION

Dr. R. D. Lewis
Texas Agricultural Experiment Station

We have in the Texas Agricultural Experiment Station 25 different programs of research. Over 250 different research projects are centered around these 25 different programs. Back in January of 1947 a meeting of this group was held here at the first turf conference, at which time it was decided to form the Texas Turf Association.

In my files is a memorandum drawn up during that meeting which outlines the needs for research on turf.That memorandum is dated January 25, 1947. Late in that year the Turf Association itself prepared this little booklet, of which I hope copies are still available. The Texas Turf Association therein announced a turf research program for lawns, parks, etc. and stated the objectives and the purposes of the organization. The second one of those purposes and functions is to stimulate and support research on grass breeding, turf culture, soil management and all other matters pertaining to the development and maintenance of turf for all uses.

At that time the Turf Association and we had very slim funds which could be used directly in turf research. We did have a background of years of work on a great number of species of grasses that were usable on farms and ranches and some of which were usable in turf. Building on that background it was decided by the Turf Association that they would go out and attempt to raise funds to support a research program here at Texas A & M on problems of turf. The objective set up was thirty-seven hundred and fifty dollars a year. We didn't get anywhere near that amount from the members and friends in the Turf Association. But we had some good workers in the program who accepted the challenge; who went ahead and actually started work without an assurance of a really adequate fund, building on the work we had underway for grasses for use on farms and ranches.

Thus we were able to get a small amount of work started in 1947. We were well supplied with assistance at that time and thereafter by Goldthwaite's Texas Toro Company which has been a fine supporter, providing equipment, supplies and funds. These funds were actually used for the training of some young men in college who were particularly interested in turf. That fund was the largest of these outside contributions. It actually has made possible the training of several boys in the expansion of this work.

Dick Potts, Ethan Holt were the workers who got the research program underway initially. In 1953 we were fortunate in getting Dr. James Watson to join the staff. He spent about a fourth of his time on turf research, three fourths in teaching turf and forage crops problems in general. He also spent much time in consulting with the people concerned with turf about this state. He was with us for a couple of years. The USGA Green Section came into the picture too during this period of time and made nice little annual grants which helped out with certain phases of this research program. We were also able to use some of our so-called State Chemist's funds on fertility aspects of turf. Then Dr. Jim felt that he would like to become a commercial operator.

Marvin H. Ferguson came in 1952 and we were able to expand the portion of his time devoted to turf research. He went on half time basis as a result of the funds provided through the Turf Association, and directly by the Agricultural Experiment Station, and from the USGA Green Section. In 1953 the Green Section proposed to us that a regional office, with Marvin Ferguson as the Director of that Southwestern Regional office, be set up with headquarters at Texas A & M. That has been done under a memorandum of agreement with the College and the Experiment Station. He is a member of our graduate staff also, and the Green Section is making a grant to support a research assistantship. Dr. Ferguson is still associated with us as a cooperator and headquartered here on the campus and he is providing service to many of you folks.

We asked Dr. Holt to assume responsibility for the work but on a part time and we hope only a stopgap basis. He also has full time responsibility for our forage grass program. So we are still searching and hoping.

Now at various times since 1947 we have gone to the Legislature and asked for appropriations for turf work. It is difficult to get across the need for adequate support of research on grasses to be used on our farms. But when we talk about golf courses along with highways, lawns, cemeteries, etc., we didn't make very much progress in getting legislative support until this last session of the Legislature. At that time we gained some recognition of research in greases and legumes, and a small appropriation for research in our program of ornamentals. Somewhere along the line the work "turf" was dropped from the bill, but when we got our appropriations I insisted that the write-up and all the justifications we had presented emphasized the word "turf". So actually I've had my neck wrung a time or two or twisted a little bit, as I insisted on placing a major part of these funds to turf research. This is the first time that the Legislature has specifically recognized this program. We will go back on that basis again. Next month we begin to prepare our budget requests to go to the Legislature for the session of 1955.

The current support for the program comes about as follows: six thousand dollars assigned from these appropriations: two thousand dollars from the Green Section as contributions, contributions from the American Cyanamid Company, Texas Golf Association, Texas Turf Association, from a number of individuals and clubs. We don't yet know just what the totals will be.

At the present time the balance on hand in the turf research fund, contributed by members of this association, is $2.16. That was the amount the Association had in the account. I've had letters and conversations however, with your officers and they have proposed that there will be a definite program for further support coming through the Association.

The intangible contributions of the Experiment Station and of the College through its various parts in the form of administration, clerical services, land, office space, and facilities adds up to a good many thousand dollars that are actually devoted for turf research.

We have been greatly encouraged the last 2 or 3 years by the developments in the outlying tests; in the work that several of you folks have been undertaking, particularly at Wichita Falls. You are to have a considerable discussion of these researches on the plots at various locations. Those here, those at Wichita Falls, those at Texas Tech, and the Stevens Park plots specifically are mentioned in the program. That's fine; because solution of some of these problems should be sought under conditions other than those we happen to have here on our campus.

I want to emphasize, however, that the field of activity of the Texas Agricultural Experiment Station is the state as a whole. It is not limited to this campus. Through our substations and field laboratories and our work on farms and ranches and our cooperative work with groups such as yours, we are able to serve the entire state.

We have definite need and we have been searching for a man well trained in turf work to take charge of this program. As it affects Marvin H. Ferguson's activities we are hoping that we can again add to rather than subtract from.

For the first time since the start in 1947 the turf program can rely upon enough resources to proceed on a sound and orderly basis. It needs, however, the continued support of the members of the Texas Turf Association! It will reward that support in the form of increased knowledge in the development and maintenance of good turf, and in the production of men trained in turf management techniques.

What have been some of the contributions of the rather small but I think this highly productive program? I would emphasize again and again that the outturns of this program have come primarily as the results of young men accepting the challenge and going ahead even though they didn't have all the funds they thought they needed. They have done a whole lot on a little. They merit our very great thanks for their determination, their vision, their energy in proceeding with the program. Those are signs of a good research worker.

The contributions of this program may be summarized in several ways. There are human contributions in the first place; the training of workers. Industry has taken several of those and that's fine. We hope that industry shall have an opportunity to take more. Now Albert Crain, Jim Watson, and Marvin H. Ferguson are all ones that have gone out as leaders from this program. Then we have a number of students who worked in turf research and who are now in the turf industry. Former students supported in part by the grants to the turf studies are: Bob Johnson, Quentin Johnson, Joe Smith, and Ed Daniel.

Then we can record some definite accomplishments in the way of service to the various industries or activities, in which turf is a prime necessity and a prime factor. There has been a fine exchange back and forth which I think has been most helpful. Such services involve a tremendous amount of extra time on the part of our turf people.

Then there are some definite accomplishments in the way of information. Out of research have come better practices, better equipment and materials. Knowledge about the better use of water has come out of turf research and other research programs, some with other crops. We now have more knowledge of the physical situation in soils and their modification for improvement of turf.

We need much more work of that sort. Greatly improved information now exists with respect to fertilization and general management of turf areas. In a number of these matters, we have made advances in the past six years.

Then we have some improved strains of bermudagrass that have come out of the program, strains which most of you have seen in our test plots. In that connection you may be interested to know that we are now seeking drought-resistant strains of grass in several sections of Texas, where they have been put to severe tests during the past 3 or 4 years. With the cooperation of the United States Department of Agriculture this last summer we set out to find in Texas, New Mexico, Northern Mexico, individual plants of grasses which apparently had been able to come through the drought situations more satisfactorily than the common run. We believe that from this collection of several thousand strains we will find some superior strains for farms, ranches and various uses of turf.

To summarize, then we have had a productive turf research program, carried at times "on a shoestring". We are looking forward to the time when with your help and your assistance we can expand this program still further, not only here but in other locations in this state.

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STEVENS PARK PLOTS

Wylie Moore
Stevens Park Golf Club
Dallas, Texas

Thank you Dr. Adams. It is a genuine pleasure to be here and to have had a small part in this turf improvement program of the Texas Turf Association. In February, 1952, Dr. Jim Watson asked Mr. L. B. Houston, the Director of Parks of the City of Dallas, to establish a small experimental grass nursery in the Dallas area. Dr. Watson was then in charge of turf research here at the college. Stevens Park Golf Course was selected for the site. It is a city owned and operated course and I was given the job of supervising the establishment of the nursery.

On April 18, 1952, Dr. Watson sent us two blocks of sod of each strain, each block being about one foot square. The shipment contained fifteen strains of bermudagrass and one strain of centipedegrass. To these, we added a native strain of bermuda that had been on the course for the past thirty years I know of, a native strain of buffalo and a strain of St. Augustine. These plantings were completed by April 24, 1952. In June of 1952, Dr. Grau suggested that we plant these vacant plots in the nursery. Dr. Grau suggested that we plant these vacant plots in zoysia. He had the Beltsville, Maruland station send us a few ounces of common, Z-52 and Z-73 seed. The seeds of each of these strains were mixed with a gallon of dry sharp sand and sowed on their respective plots. The plots were covered with a straw mulch and kept damp until the seed had started to sprout. A little straw was removed each week until the plants were strong enough to withstand the hot weather we were having. In the following month after seeding, we had about ten days that the temperature reached and passed 100 degrees. This completed the nursery, we had twenty-two plots each plot 10 x 20 feet.

I have brought some colored slides, showing the progress of these plots that I would like to show you. This first slide shows the location of the nursery. It is located about four and one-half miles from downtown Dallas, on Oak Cliff Boulevard. If any of you are in the vicinity of Dallas, we would be happy for you to visit the nursery.

The next slide please. This is a front view of the nursery, on your left, we have T-35A, T-47, T-22, T-8, T-11, common zoysia, Z-52, Z-73, a native buffalo, T-12 and T-55. On your right, we have T-109, T-76, T-17, T-29, T-13, B-57 which is Tifton 57, B-12 which is also another Tifton strain,centipede,St. Augustine, U-3 and our Stevens native strain.

This is a view of the back end of the nursery. You will notice the plowed soil at the end of the nursery. It is a black clay with some small white limestone in it. We did not do a lot of special preparation of this soil. It was plowed several times and some compost material was plowed and worked into the top soil before leveling. It is the typical soil found on most of the course.

This is T-35A;it is a fine textured strain of bermuda. It has no rhizomes and spreads only by runners. It is strong and vigorous and forms an excellent putting surface free from grain. When well-established it will hold the common bermuda out of the putting surface of the green. This is not a good picture but you can see the root development. Many roots are extending from the bottom of this soil profile sampler.

This is T-8; it is much like T-35A in texture, color and other characteristics. The only visible difference is that an exposed runner will appear in well established turf which is not detrimental in a putting green because of its density. You have seen from Dr. Holt's slides, the density, texture, color, weed invasion, disease, drought, growth, and spread of allof the better strains here at the college. I think T-8 showed a little improvement by moving it to the Dallas area. We are about 200 miles north of College Station and have had mild weather for the past two years. T-8 has a tendency to throw up seed heads during hot weather which can be controlled with a brush or comb on the putting green mower. T-11 is another fine textured strain and has all the characteristics of T-8.

This is T-47; it is a strong strain of bermuda. It forms a dense, tight turf, more suitable for athletic fields, parks, tees and fairways. You will notice that the nursery is mowed at two heights of clipping, one at three-fourths inch and one at one-fourth inch. The close clipping did change the texture of the courser strains like T-47 to about the texture we find in common bermuda.

This is T-17; the texture of this strain is similar to common bermuda. Its rate of spread was the best in the nursery. In four weeks after sprigging, it had completely covered the plot.

This is U-3; most of you are well acquainted with this strain of bermuda, but were rather disappointed in it the first year. You can see how it is being encroached upon by St. Augustine and our native strain of bermuda, but the second year it really bounced and regained some of the plot. U-3 is cold hardy and it takes several hard frosts to show any effect. It is first to show new growth in the early spring. Its texture is narrow enough for putting green use but has a tendency to thatch and become grainy.

This is T-22; its texture is much like common bermuda but it is more of an open type of turf.

This is T-109; it was the slowest spreader in the nursery. It has an unique formation of its leaves at the joint of the runner. When established it did form a dense tight turf.

This slide shows the common zoysia, Z-52 and Z-73. This is an early picture of these plots. There seems to be more plants on the common zoysia plot. I think Dr. Grau sent us four ounces of common seed and two ounces of Z-52 and Z-73 seed. These plots were seeded on June 16, 1952 and this picture was taken about the middle of August. 1952 was a major drought year for Dallas and all the water that these plots received had to be pumped out of a creek that runs through the course into a tank truck and pumped out of the truck onto these plots.

This is a view of our experimental green. This green was sprigged on April 21, 1952 with T-35A, T-8 and U-3 bermuda. It was opened for play on August 17, 1952. The T-35A is on the back of the green and is a strip about 20 feet wide. T-8 is next and is a strip about the same width; you cannot distinguish one of these strains from the other. The next light colored strip is U-3 and is about the same width as the other two. The narrow strip at the front is about five or six feet wide and it is a mixture of T-35A and T-8. We had run out of U-3 and the T-35A and T-8 had started putting out long runners. Dr. Grau suggested that we rake up some of the runners on the back of the green and sprig them out to complete the green. This green has had about 50,000 players on it last year. It has 4000 square feet of putting surface. The players like to putt on the T-35A and T-8 better than the U-3, they are finer textured strains than the U-3. The golfers will determine to some extent what strains we will use for putting greens.

We came from two square feet to two acres of T-35A in two seasons. This is a view of our two acre nursery of T-35A, located at Sargent Switch near the sewage disposal plant at the end of Morrell St. in the Trinity River bottoms of Dallas. The soil is a sandy loam and was plowed one-half dozen times. 800 pounds of 20% super-phosphate was plowed in the last time the two acres was plowed. We sterilized the soil with Dowfume MC2 gas before sprigging the T-35A. We had never used any of this material before and Mr. Ralph Rowley, who is the manager of Goldthwaite's Texas Toro Company in Dallas was kind enough to come out and help us arrange our plastic tents to get started. We finished sprigging this two acres on August 24, 1953 and before frost we had about 98% coverage. We located this nursery near the sewage plant because we were assured an ample supply of sewage water which has some fertilizer value, the amounts, I do not know. In designing the sprinkler system, we talked to the engineer at the plant. He told us that they maintained a 65 pound pressure except when they were washing down at the plant and that a six inch line ended in the yard that we could tie on to. Mr. Ray Tirbble, the Park Department engineer who was designing the sprinkler system suggested that we design the system for 30 or 40 pounds of pressure and it is a good thing he did because when we went to tie onto the line in the yard, it was a 2 inch line. You can see in this picture that we were not getting full coverage from our sprinklers! Some hand watering had to be done. But since that time the sewage plant has installed a new pump and maybe we will not have any more hand watering. It was my responsibility to choose a strain of bermuda for this two acre nursery. We had 4 good strains to choose from. I talked to Dr. Holt, Dr. Watson, Dr. Potts and Dr. Ferguson, and they all gave me the same answer. "Pick the best one". I was in the same predicament down here at the college in 1922. I came down here with the Dallas County Agricultural Agent as a member of his poultry team for a summer short course. One morning they took us out to the horse barn where several horses were in the corral. We were handed a card and told to judge the horses. I told Mr. Charlie Sherill, the assistant agricultural agent, that I was a chicken man and that I did not know anything about horses. He told me "Just go out there and pick out the best one". They were all good horses and the same goes for these strains of bermuda. They are all good. The T-35A, T-8, T-11 and U-3. I think T-35A was selected because it responds to nitrogen fertilizer quicker than the other three strains, enabling it to recover from heavy traffic. The seed heads on the T-35A are not as large and do not require as much brushing as the other three strains. These finer textured strains are not miracle grasses. They require a well-drained soil and better greenkeeping methods.

This is a typical bermudagrass green that you will find in Texas. You can see at least six strains of common bermuda in this green. It is not an ideal putting situation; the texture runs from coarse to medium and would require top-dressing every three or four weeks to keep a fair putting surface. Those of you with common bermuda greens sooner or later will have to come to some fine textured strain. I think we are going to make a lot of progress in improving the playing conditions of our golf courses.

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Research Reports - Texas A & M Plots

Ethan Holt

Dr. Holt needs no introduction to you. He is going to talk about the work on turf here at the College. In this period in which we have been without active leadership in the turf work, Dr. Holt is happy to handle this work on a full program. That may not sound as the truth but I hope its more of an explanation. He does have the work well in mind and he will now talk to you on some of the phases of the work that we have here at the college.

Thank you Dr. Adams. I appreciate this opportunity of reviewing at least briefly some of the work which we have done here on turf. This morning I am only going to have time to review with you rather briefly two or three of the tests which we have had underway there for a period of 2 to 3 years. You have had the fertilizer work mentioned to you on a number of occasions previous to this and maybe some brief results were given at last year's conference. However, since that time we have accumulated additional information. I would like to spend most of my time this morning talking about the results of the fertilizer work which we have conducted here starting in the spring of 1952.

I would like to take a little time to review the setup of the fertilizer study with you since it may be a little unusual or a little complicated for those people who are not very familiar with research and research methods. In an attempt to determine what fertilizer applications are the best, this study was set up in what we call a factorial design. That is, we chose various rates of nitrogen, phosphorus, and potash and those were applied in all combinations. If we take an example in this test, we had nitrogen applied at 0, 4, 8, and 12 pounds of N per thousand square feet. We used the same rates with phosphorus and with potash. In the test when we have a combination of 4 pounds of nitrogen with each of the other levels of phosphorus and potash so you can see this progresses rather rapidly in number of plots. We have all combinations of those four rates of three different elements giving us sixty-four total treatments in this test. That is a large number of treatments to work with and we are not going to make any attempt this morning to review all the data which has been accumulated. From this type of design it is possible to determine what level of each of these nutrients is necessary to obtain the growth or other characteristics we may be looking for in turf. You may find that you need a high level of nitrogen, a medium level of phosphorus, and a low level of potash for best development. From this type of design it is possible to determine those types of ratios.

It is always a problem in conducting this type of study as to what measure should be used for determining which one of these treatments is best. We normally use, in our forage production studies, yield as a measure. Most of you people in turf are not concerned with the amount of clipping which you remove from the plots. However, you are concerned, I think, with a grass which continues to grow throughout the entire growing season. Yield is the best measure we have of that growth. For that reason, in this test, we have used yield of clippings as a measure of the effect to these various fertilizer treatments. We wanted a treatment that would produce continuous growth throughout the growing season. Now, along with that is the need, of course, for some measure of the influence of these treatments on turf quality itself in addition to yield. Such factors as density, texture, color are important. We have had some difficulty in this test in actually getting at some of these other factors. Those problems are not completely solved yet. If you clip plots often enough to give the best turf quality, then you don't get enough clipping to measure from the yield standpoint. If you clip the plots seldom enough so that you are getting yields which are measurable, then maybe some of your best treatments are too severely defoliated, and therefore, you may have negative relationship between yield and turf quality. This is one of the problems that has been encountered in this study. The main measurement that we will report on this morning is that of total yield, and we think this will, under proper clipping management, be closely related with turf quality. I think with that introduction we will go right into the slides. I don't have any date to hand out to you, but we do have a number of charts and tables on slides demonstrating some of the effects of fertilizers on bermudagrass.

This test was started in the spring of 1952. As it was set up originally, the phosphorus and potash were applied in the spring except for the 12 pound rates which were split, with one half applied in spring and one half in the early fall. The nitrogen treatments were all split. The 4, 8, and 12 pound rates were divided by 4, with one-fourth applied at about monthly intervals in the spring and the final one-fourth being applied in the early fall. When we get into some of these slides I will give you the exact dates of application of these. These treatments were applied in the spring of 1952 and the same treatments were repeated again in the spring of 1953. I think most of you are familiar with pounds of nitrogen, phosphorus, and potash per thousand square feet. These rates go to a rather high level. For those people who may be dealing with parks or cemeteries and are accustomed to thinking in terms of acres, the 12 pound rate amounts to about 500 pounds of nitrogen, phosphorus or potash per acre annually.

The first slide gives total production of clippings per plot in grams for each of these nitrogen treatments in 1952. That is, for the zero 4, 8, and 12 pounds of nitrogen per 1000 square feet along the bottom scale. This is simply the total yield for the four rates for the season. That is averaged across all the other treatments. That may seem a little complicated to you, but let's forget about everything except nitrogen at this time. If we think only in terms of nitrogen at this time, we have this amount of clippings, about 400 grams total for this small plot, with 4 pounds of nitrogen per thousand square feet. You can see with each higher rate we increase the growth on these plots and it is almost in a straight line. Actually in 1952 the only effects we obtained on these plots was from nitrogen. We obtained no effects on yields from the application of potash and phosphorus.

Now if we could have the next slide which gives the yields by clipping dates. During 1952 the plots were clipped at weekly intervals beginning on June 19 and continuing through until the first of October.Actually there is one period in here when we did have two weeks between clippings. This chart may look a little complicated right off, but what we have is the yield for each of these levels of nitrogen and you will have to become accustomed to referring to 0 as an application of nitrogen. Again dealing only with nitrogen and plotting the growth of those plots at weekly intervals throughout the growing season, the solid line in this case is the growth of the grass on the plot receiving no nitrogen. I think you can notice that with all of these we are getting more growth from the plots receiving nitrogen than those without nitrogen. There is one point here where they are almost as poor as is the check plot which received no nitrogen. The first application of nitrogen was made in May, the second application on June 1, the third application around

July 1, accounting for this increase in yield. The final application was made over here on September 1, again accounting for the increase in growth that we have here in early fall. There is a little increase here which I think we can attribute to rainfall even though these plots were irrigated every week.

The next slide is taken from the one previous and in this case we have called the check plot or the plot receiving no nitrogen zero and have drawn a straight line for it. The three levels of nitrogen are then represented as changes either above or below the check plot. You can see that we have produced more growth by the application of nitrogen then we did on the check plot.

We go ahead to the next slide which is the 1953 yields. In 1953 we did get increases in yields from the use of phosphorus. We also obtained a nitrogen phosphorus interaction; that is, we had better yields where both were applied than where only one of them was applied. In this slide we have taken only the effect of applying nitrogen and you can see that is almost a straight line; that is, with every increase in nitrogen we got increased growth on these plots.

The next slide takes this by clipping dates and we handled this a little differently in 1953. These do not represent total yields but are five dates spaced throughout the growing season. The plots were mowed and the clippings removed the remainder of the time, so we may have tended to bring these treatments closer together because we have thrown away some of the better yields from the high plots. This, you can see, is the production per plot with no nitrogen; the plot receiving four pounds maintaining a higher level of production throughout the whole season; 8 pounds the same way; and 10 pounds giving us the most production at every date.

In the next slide we have shown the effects of applying phosphoric acid across all levels of the other two treatments. We can see that we start off with the production of about 165 grams of forage per plot per clipping where we have no phosphorus. That is increased when we apply eight pounds, but when we go on up to twelve the yields are actually decreasing. When we applied 12 pounds it was apparently too much on these plots and we got a depressing effect. This, let me repeat, was a split application with 6 pounds being applied around the last of March and 6 more pounds in late August or early September. In the next slide we have taken these phosphorus effects and plotted them as we did the nitrogen in 1952 by taking no phosphorus as the check plot and computing all the others on it as a base. At one time we actually did get less production from the four pounds than from our check plot. The eight pounds per thousand square feet was our best treatment.

Now we have a table which shows the combinations of these two treatments and we have left potash out of this table because, even in 1953, we did not get a potash effect.

Total yield per plot with various rates
and ratios of nitrogen and phosphoric acid
1953

Treatment		Grams	Treatment		Grams
NO	PO	114	N8	PO	337
	P4	127		P4	340
	P8	182		P8	402
	P12	127		P12	342
N4	PO	234	N12	PO	404
	P4	256		P4	460
	P8	313		P8	481
	P12	230		P12	455

You can see that if you apply four pounds of nitrogen the yield is actually increased above any of the plots receiving no nitrogen. However, by adding phosphoric acid to that we get still better growth of the grass up until we get to the 12 pound rate. I think you can notice with each of these treatments, by adding phosphorus along with the nitrogen, we have improved the growth of the grass. If we were interested only in total yields we would use 12 pounds of nitrogen annually and eight pounds of phosphoric acid. I think we will have to get some additional data from these plots before we can settle on the most desirable treatments. We have observed from this data that in 1952 we had no effect of phosphorus while in 1953 we had an effect. Based on many of our tests with grasses under pasture conditions we find that then we have high rates of nitrogen and phosphorus after a period of time we began to need potash also. I think we can expect that to happen in this case. There was some slight tendency this last year for potash to further increase yields.

There are two additional tests that I would like to mention briefly. I have only two slides each for the putting green strain test and the lawn species test. This data was taken in May 1953. The first column gives a density rating, with the higher ratings being the denser turf. These strains were selected partially on the basis of density so we would expect they would all have fairly good density. You will note, however, that they do differ in this characteristics with some being poorer than others. I think you are familiar with most of these strains so that I am not going to go into much detail on these. Most of them are fairly fine types which Mr. O. J. Noer discussed, rather thoroughly in one of the sections yesterday and I don't think we have time to go into that this morning. You will notice that we have taken texture notes on these. This, of course, is a relative term that means nothing more than that one is a little coarser than another within this test.

T-47 was selected primarily as a lawn or heavy duty turf and some of these others are fine types mostly for use on putting greens. Some of these ratings may differ a little to what some of you have observed. In this case T-8 is a little coarser than T-11 which we have called medium coarse. At other times of the year we have rated both of them as being fine. You notice we have T-35A as a fairly fine type. T-55 is the African bermuda, which we consider as one of the parents of these other fine types, we expect to be finer than they are. T-94 is actually given a different species name. The strains have been rated as to whether they were remaining in place, spreading into adjacent plots, or being invaded from adjacent plots. As was stated yesterday, if these fine types are to be used on putting greens or elsewhere they have got to be resistant to invasion from common bermudagrass. I think that this is a significant factor in these plots. If you will notice, some of these were given different ratings and actually we need these under a wide range of conditions. One of these strains might be next to one which was weak and it would creep over into that plot. It could be next to one which was more vigorous than it and therefore be invaded so that we may have a rating on these plots both of spreading and being invaded. You will notice that our Y-8 in these plots had been invaded to some extent. T-11 was tending to remain in place with some invasion. T-35-A was tending to spread. T-55 which is our African bermuda was tending to be invaded. So on down the line on these others.

These plots have been rated four times for color. The December ratings will indicate to some extent the frost damage on these plots. You will notice that we have some which still have good color in December, others which are very poor. In February the highest ratings indicated the best color and you will notice some of those which were fairly good in December are not the best in February. This was in February 1953, and we had a very mild winter as you know. I think that would indicate some ability of these plants to recover during warm periods and put out a little green growth. Color is a matter of personal perference and we cannot say that a light green is better than a dark green.

In the lawn test we have made the same types of notes that we had on the putting green test. This is common zoysia and it has been invaded. Many people consider St. Augustine to be a shade grass, but when given sufficient water it will spread into these other types of grasses including bermuda because of its very dense growth. We know that St. Augustine is very coarse. In this test there is very little difference among bermuda strains in the density ratings.

Now we have the color ratings through the winter again giving some indications of frost tolerance among these species. I would like to point out first that you know St. Augustine will stay green in the fall until it gets extremely cold. When you have it out in the open it will go completely brown and it does not respond to warm periods as some of our bermuda will. You notice that this time bermuda was rated much poorer than St. Augustine, but when we have a warm period bermuda will tend to green up and St. Augustine will not. The last column is simply an indication of the shade of green of these strains.

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EXPERIMENTAL PUTTING GREENS IN EAST TEXAS

Joe Smith

Following along with what Wylie Moore said, we will go to the finer strains of bermudagrass in East Texas. Last summer while traveling in Northeast Texas and visiting the golf courses in my territory, I found an increasing demand for new strains of bermudagrass. Golf Course superintendents came to me and asked which strains I would recommend. Looking back on information we have, I find that we know very little about them even though we have had a test going on here at College Station for seven or eight years and one in Wichita Falls for a few years. As far as the East Texas Territory, we know very little about adaptation, and what strains would do the best.

With that in mind I hit on the idea that if the golf courses were interested in new grasses, they wouldn't mind testing a few of the promising ones on their own grounds. Marvin Ferguson and I, having discussed my plan, picked six different strains that we thought showed the most promise here last year and that might fit the conditions found in East Texas. The strains we picked were T-35A, T-94, T-83, which is Gene Tift sometimes called Bay Shore, T-82, T-8, U-3. In all the tests common bermuda was used as the check. One of the courses that I set up for this study just so happened to have T-57 on three greens, so that made seven strains under study there. We started with seven golf courses, but only five were completed last year. The five were Denison Rod and Gun Club at Denison, McKinney Country Club at McKinney, The Indian Hills Country Club at Atlanta, the Jacksonville Country Club at Jacksonville, and the Henderson Country Club at Henderson.

It takes me approximately two months to cover my territory and consequently I could not be at the clubs when the grass was set out. We made a lot of mistakes and most were made when putting the grass in. Originally we had planned to use a pie shape design. Visualize a large pie with the pieces being the different strains of bermuda, all pointing toward the center. Dr. Ferguson and I thought that with this design we could obtain a more accurate evaluation of wear-resistance. The inner circle probably would receive more wear than the outer circles. As expected, most of the golf clubs changed our design. We had only two golf courses that followed the design out to the letter. The others did put the strains out in the proper manner, but they were in different designs and consequently will change our method of evaluating the grass.

The most important reason for setting out these strains is to let the players evaluate the grass. We can come to the Texas Turf Association meetings and say which one grows the best and which ones produce the best putting surface, but it really is the player that a golf course superintendent has to satisfy. The most important information the Texas Turf Association and other golf courses in the state will receive is how these grasses will react in East Texas under varied management practices. Although the studies have only been established for about three months, we already see indications that management is going to play the most important part in performance of these fine-leafed strains.

To evaluate the performance of these fine-leafed strains, we used three sources of information. One from the members themselves, one from the greenkeeper and one from records kept by myself. The member's evaluation was obtained through the use of a score card with texture, putting quality, and color being scored under each strain of grass.

From each superintendent I requested completion of a form sheet which covered details of planting top dressing mixtures, rates, type and number of applications of fertilizers, watering practices and other information which would help me determine the management practices of the golf course. On my regular visits, I have kept a pictorial record of the study along with notes on vigor, cold and heat tolerance, drought resistance, color, texture, thatch and mat formation, weed invasions,and general putting quality.

I would like to show some slides now, Dr. Potts. This is one of the best managed courses as far as our strain tests is concerned. This picture was taken just after they put the grass in this past June. You see how they laid it out in rectangular plots. We use a planting rate of about one square foot to twenty-five square feet. Each plot is approximately 150 to 200 sq. ft. On your left is U-3 bermuda, next to that is T-82, next to that is T-83 which is Gene Tift. Coming this way, we have T-35A and in this corner is T-94. The seed-bed of the testing area at this particular course received over four pounds of nitrogen. It was heavily fertilized all through its growing season and later pictures show that it did pay off. This was taken two months later. As you can see they are completely covered and play has already started. I was informed that within four weeks the members were playing the green and considered it a fair putting surface. Keep in mind this is the one that had been well fertilized coupled with controlled watering and a very good top soil mixture. They used sharp sand, decomposed organic matter mixed with a soil which is about a medium to fine sandy loam.

This next slide was taken looking down the whole row. I believe the manager of that course is here with us, and I would like him to help me out if I do get mixed on the arrangement of the plots. We are still looking down the area with U-3 at the end. This again was taken two months after it was established. In the background you can see the common bermuda. Notice the color. That was treated exactly the same way as the plots in the foreground. At the bottom of the picture you see T-94 again foloowed by T-35A, T-83, T-8, and U-3. Notice that even at this distance you can see how coarse U-3 has turned out. On this particular course, T-94 walked away with the honors. That is the strain here in the lower part of the picture. U-3 was the poorest in our estimation as far as putting quality, texture and the color. I think you can see that from this picture. Second choice was Gene Tift and T-35-A.

They liked the putting quality of T-35A exceptionally well. They didn't like the color as much as they did the T-94. As you can see, it is the darkest one in the study. Here is Mr. Hanan showing the stemminess of U-3. After only two months, you can see how tight the turf is. One objection to T-94 already is indicated there in this one year test. Even though it was only established for two months, it started to form a heavy thatch condition. I don't know how that will prove out next year, but it did show that some thatch preventing management will be necessary.

Now here is just another one of the things that I was saying about putting the grass in and not caring for it. This is one of the golf courses I would say wasn't used for seven years, just scrapped off the top and put the grass in. This particular green took over nine weeks to cover where the other one took four. They fertilized, using one pound of nitrogen for the whole area which was definitely a small amount for the seedbed preparation.

The following pictures will show the effect it had on the grass. In the background to the left of the men, you can see the U-3. That is the only one I recognize on this slide. Your T-94 with the lower fertility rate didn't cover as fast. It is the one right in front of the men. As I said before, I think we are going to find that management practices are to be the deciding factor in getting good results from these strains. This was taken a month later. Now your T-94 has finally covered over. As you see, it is offering more competition to the weeds already. It forms a very thick mat. The strain in the background is U-3; on this slide we have T-35-A a leading right on into the point of the T-94 plot. Now you can see T-35A on your right and T-94 over there. Here again is T-94 with U-3 bermuda, T-83 which is Gene Tift is in this section, T-82, T-8, and then around T-35A. This club decided they wanted to extend the green out further with common bermuda around here. I wouldn't let them put any of the manure they used on the testing area. I advised them to keep it on the outside of the circle as you can see in this picture. It wasn't mowed, it wasn't topdressed out. That is why in this experiment this year the only reliable player information I do have is from the first course. They are the only ones that started playing the green and sent me date to supplement my observation. This picture was taken at the same time. This was three months after it was put in. Still we do not have a putting turf. They are finally starting to mow it and picking a few weeds out here and there. Here it is looking a little bit better. This was taken several weeks later than the last slide. You can see they are mowing a little more frequently, but are not treating it as a green yet. I believe next year they might get to it. Now you notice that all the weeds are out. I wanted to show you those two courses, because they are typical examples of the way the tests are going. I have pictures of the other tests also. One is very poor. The grass was sent to him at a time when they were fighting the army worms and they just didn't have time to put it in. They set it out in sod blocks. But even these set backs give us a little information which might be helpful to the group. There has been a lot of talk about T-8. Dr. Watson and I were talking about it yesterday and he said it proved to be very drought-tolerant. I found out it wasn't drought-resistant. The strains were set out in the blocks as they came to the Experiment Station here and weren't watered for approximately four weeks. At the end of four weeks, all of the grass was wilted. They were on a sandy soil to begin with, but the T-8 was absolutely gone and once they started watering again it failed to come back.

As far as some of the observations made on the weed invasion, T-94 took the first honors. In the last slides, here I believe you saw that T-94 was the first one to seemingly resist the invasion of your dallisgrass and gradually crowd it out. Of course, the only way they got the dallisgrass out last fall was to pull it out. But it definitely limited the growth of the dallisgrass and looked as if it had helped push it out. Again T-94 had the best color of all.

I do want to quickly summarize the one course with the T-57 under study. That was the poorest managed course in the whole experiment. They didn't fertilize at all when they put the grass in and they didn't fertilize as it was growing. They weren't completely covered by the end of this season. When I was there in November, they still didn't have complete cover. They weren't playing on it--they couldn't. But the T-57 and the U-3 covered over completely. Although they are both very coarse grasses and definitely are not recommended for putting greens, they were the ones that showed more drive under low fertility conditions. The greens weren't constructed properly either. They were very hard and made up entirely of fine sand and very little organic matter.

In summary, I believe it can be said from these first year results, that the golf course members definitely think that T-94 showed more promise as fas as putting quality, texture and color. I only received reports from the one course that did play it. I'm sorry I can't report on the other ones, but I am sure from my observations that it would hold true on all of them. As far as cold tolerance is concerned, they all showed greater tolerance than common bermuda this year. They stayed green until the last freeze we had on December 18th. Again the T-94 was the last one to go dormant and turn off color. It stayed green about a week after the freeze. As for drought-resistance, they all seem to hold up well except T-8 which will definitely be affected by prolonged periods of drought. T-35-A showed a little less drought-tolerance than any of them.

That is just about all I have on the performance of these tests this year. I hope by spring we will have some more reliable data that can be made up in a report and sent to the members of the Texas Turf Association and other interested parties. If there is anyone in my area of travel that would like to start a test such as this, I will be very happy to arrange for the grasses to be shipped to you and lay out your design for you if you would like to keep an accurate check on it.

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CONSERVATION OF WATER THROUGH USE OF SPRINKLERS

John B. Gill

A sprinkler will not conserve water; a sprinkler will not promote deep root growth of grasses; a sprinkler will not give you a more luxuriant turf; but - intelligent use of a good sprinkler will help to do all of these things - plus savings in time, money and labor.

Recentlu I attended a Turf Conference at which nationally known authorities on turf were scheduled to speak. I was told beforehand that these speakers were outspoken against the use of sprinklers. I had been told that their theories advocated the elimination of watering and that their advocations would in time hurt the sale of sprinklers. The "crepe hangers" did a bang up job in selling me on the idea that these speakers were on the opposite side of the fence from me in business. Naturally, I was most interested in what they had to say and listened attentively. Strangely enough, I heard nothing like what I had been told to expect. The only thing that I heard about watering was a profound statement that I think should be repeated here. I may not have the words verbatim, but in effect the statement was that the most common mistakes made in watering is "watering too little too often, and that the rule should be to water well less frequently". I made up my mind that these men are my friends and that they had been grossly misunderstood and misquoted.

I do not propose to tell this group or any group how much or how often water should be applied to turf. I do not propose to tell any individual how often or how much water should be applied to a particular piece of turf. I want to tell you why. Some soils are sandy, light and porous; some soils are tight and heavy. Soils vary in different parts of the country. Soils vary in different parts of a small area. Some grasses are more drought resistant than others, but they all have one characteristic in common - they must obtain their food in a liquid form. Plant nutrients must be dissolved or ionized in water to be taken up by the roots and carried to the grass blades above ground where photosynthesis and transpiration takes place. How much water is available to carry this food depends on the type of soil, drainage conditions, climate and other factors. The availability of water in the soil is primarily the function of nature, but more often than not where man tries to force more than what nature naturally produces in plant life, man must supply the necessary additional helps. Supplemental water is needed just about as often as supplemental food.

The problem of making water available to the grass roots is one for the individual turf manager to solve on his own grounds. We hope that we can by our experience give him suggestions that will help make the job easier, but the problem of how much and how often is his to solve.

Plant food is applied to the surface. The problem is to place it where the roots can get it. Plant food cannot be carried downward until water percolates it through the soil. Liquid fertilizers must be mixed with water. Dry or solid forms of fertilizer must be dissolved before the nutrients can be carried to the roots. No matter how the plant food is applied, water, supplied by nature or man must carry the nutrients down to the root structure.

Good drainage is just as important as water application, sometimes even more so. Good drainage permits free passage of water carrying nutrients, and helps to keep the soil tight and aerated. It goes without saying that aerating or spiking is an important part in watering and drainage. It is the tie-in between watering and drainage. Avoid soil compaction at all costs.

I think we can all agree that water is necessary to the life and healthy growth of good turf. So-called controversies over the use of water really resolve themselves into debates over the proper amount and frequency of application rather than over the question of whether or not to water.

I said earlier that I could not tell you how much or how often water should be applied to a given piece of turf, but I can tell you how to most economically apply it in measured amounts over a given length of time. The function of an irrigation engineer is to design watering systems with the physical capacity to do the job that is necessary for the maximum requirements. The brains to operate the system are not included with the sprinklers.

The frequency of application is up to you. Only you can know from your own experience how much and how fast water can be applied to the soil on your grounds. Only you can tell from having lived with your turf over the years how much water your soil will hold and how fast it can be applied without sealing off the first few top inches. A tubular soil tester for taking out test plugs is not only a desirable tool, but is a necessary tool for any good turf manager.

The water holding capacity of the soil is an important thing to know. Knowing how much your soil can hold is just as important as knowing how fast it can take it without run-off or sealing.

Let us assume you have determined these things for yourself about the soil on your own grounds, and that you would like to design a sprinkling system to make it easier for you to keep your turf up to "spring fresh" condition during the hot summer dry months. Good green turf all summer long under drought conditions are possible if water is correctly and adequately applied. Most failures of water systems are due to under-design of the watering system, because watering systems must have a capacity to take care of the maximum adverse condition.

Continuing with our assumption that you have determined the holding capacity and best application rate for your soil we will proceed to design a sprinkling system to suit your needs. Our purpose is to show you the method of approach to the problem. Each property is different. That is what makes each project an individual problem, but the approach to the problem is very much the same in all cases.

For the sake of easy mental arithmetic we will assume that you have an acre of ground to cover. The size of the area is the first important bit of information to have. Next we will assume it has been determined that your ground will need at most 1" of rainfall per week to keep healthy turf alive during your driest seasons.

The next step is to determine the kind and number of sprinklers to use. The physical lay-out of the property is sometimes important in selecting the proper sprinkler. Large open areas permit the use of long range sprinklers, while irregular shaped grounds, buildings, trees and shrubs all contribute to your problem in selecting the kind of sprinkler best suited to cover the area. Part-circle sprinklers are often best used around buildings and structures to avoid throwing streams of water directly on them. Small diameter sprinklers are obviously used to good advantage in and among large plantings and shrubbery.

To keep our problem simple, we will assume that your acre of ground is open and permits the use of long range sprinklers. At this point we have several factors to consider.

We must know the coverage diameter of the sprinklerwe have elected to use. Knowing this we can determine the number of settings that will be required to cover the acre; but, most important of all, we must know the precipitation rate of the sprinkler in terms of inches of rainfall per hour. This will help us to determine how long the sprinklers must sit on each location and how many hours weekly will be necessary to apply the 1" of rainfall that we have already determined will be needed.

First, we know that an acre inch of water is 27,154 gallons. We know that because we can find it in any good information table. It is usually easier to look in some good pump catalog or sprinkler manual than to figure it out ourselves even though we know that a cubic foot of water contains 7.48 gallons.

We will assume that we have a working week of five days. There are eight working hours in each day, but some time should be allowed for setting out the sprinklers so we will assume that the sprinklers will be set only six hours per day. This allowing a lot of time for setting the small number of sprinklers that we will use, but six hours are about the actual number of hours that sprinklers are often operated on large turf areas. Six hours per day, five days per week give us a total of thirty operating hours in which we have to cover the acre of ground.

By consulting a sprinkler performance table we find a sprinkler that seems to suit our needs. We find that it will cover a diameter of 100 feet on a nominal pressure and deliver 0.17" rainfall per hour. Over broad expanses of turf the most even pattern of distribution from sprinklers is obtained by placing them on equilateral triangular spacings of about 65% to 70% of the diameter of sprinkler coverage.

Assuming a 65 foot triangular spacing for the 100 foot diameter sprinkler that has been selected, we find that approximately eight settings of the sprinkler will be required to cover the area. Knowing that the precipitation rate is 0.17" per hour, each sprinkler will have to operate 6 hours on each location during the week to deliver a total of one inch. Whether this will be done in one setting, two settings, three settings or even six settings will depend upon your experience with your own soil. Generally speaking, and assuming conditions to be ideal, it is usually best to operate the sprinkler for longer periods of time less frequently than to operate the sprinkler frequently for shorter periods of time. Whatever you determine as to length of setting and frequency of application, the total number of hours required to deliver one inch of rainfall remains the same because the precipitation rate will be constant at the pressure determined,which should also be constant.

Continuing with our problem, we find that the sprinkler we have selected will consume 10.1 gallons per minute. We have determined that each sprinkler must operate a total of 6 hours and there are eight settings to be made therefore a total of 48 sprinkler hours will be required to cover the acre. We have already determined that we have only thirty hours to do the job. Thus we see that with two sprinklers we can cover the acre in twenty-four hours of operation or with four sprinklers we can cover the acre in twelve hours of operation. If we select two sprinklers our water supply must be at least 20.2 gallons per minute, and if we select four sprinklers our water supply must be 40.4 gallons per minute.

The sprinkler we have selected operates on thirty-five pounds pressure, therefore, our next job is to get the required number of gallons per minute to the sprinkler with sufficient pressure. By the use of simple friction loss tables, the irrigation engineer determines pipe sizes and pipe lay-out as well as pump capacity and horse-power requirements,if the latter is needed. Often as not, the engineer will have to design the system to fit an existing water supply. The existing supply may be of sufficient quantity and pressure and just as often it will not. Do not be surprised if your irrigation engineer recommends an increase in horse-power or pump capacity. Working from an existing supply such as a city water system main, it then becomes a problem of ascertaining from the water works engineer just how much water and at what pressures it is available.

Sprinkler systems can be of different types. They can be the "fixed spray" type most often found on small home lawns. The precipitation rates on small lawn sprays is very high. On large areas the large, rotating type of sprinkler is not only advantageous from a cost standpoint, but in most cases the lower precipitation rates made possible by this type of sprinkler are more desirable.

Rotary pop-up sprinklers are the best for labor saving and cost saving over the spray type on large areas. These sprinklers are connected to common control valves and several of these sprinklers operated at one time over a large area by the mere turn of a valve.

The Quick-coupling system is most often used on golf courses and extremely large areas because of their comparatively low cost and efficiency. Quick-coupling systems cost about one-half to two-thirds as much as Rotary pop-up systems, and are more flexible in operation. Each sprinkler out-let is individually controlled whereas on Rotary pop-up systems the individual control is over fixed batteries of sprinklers.

Few people think of hose sprinklers in connection with sprinkler systems,yet some efficient sprinkler systems can be designed to use hose sprinklers. Properly laid out, the greatest amount of efficiency can be obtained from hose sprinklers by planning the exact location of all sprinkler settings. Properly spaced sprinklers settings will reduce the number of valve openings. Usually five settings can be made from each valve opening with hose lengths kept to the exact triangular spacing as determined by the spacing design. Sprinkler setting markers can be easily made by cutting up your old worn out hose into 8" or 10" lengths and burying them vertically in the ground at each sprinkler setting location. They are out of sight and out of the way of mowers but the watering operators will have no trouble in finding them .

Often as not hose sprinkler systems properly laid out can be converted into hoseless systems in later years. Sometime hoseless systems are installed piecemeal by first designing a completely hoseless system and then cutting out the appendage branches and installing only the main lines for the first project.

More and more water companies and their engineers are coming to recognize that properly designed sprinkler systems are a water saving device. Experience in the hot San Joaquin Valley of California has long ago proved the value of sprinkler systems as a water conservation measure. If you want to get the most for your dollar spent, go to a good irrigation engineer. The best will cost you no more, and will save you money, time and headaches for years to come.

The irrigation engineer should design the sprinkling sustem with the physical capacity to take care of your maximum load requirements. Do not expect him to tell you how much and how often water should be applied.The latter is an empirical problem that can be determined only by you. Weather and soil conditions will change as time goes on and watering schedules will have to be changed accordingly. Consult your Agronomist from time to time if you need help. Between the two of you the rates and frequency of application and total amounts to be applied can be determined to suit the immediate need.

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WATER IN RELATION TO PLANT GROWTH

PANEL DISCUSSION

TEXAS TURF CONFERENCE
College Station, Texas
January 18-20, 1954

The topic for discussion was "Water in Relation to Plant Growth". This subject involved discussions of the roles of water, the relative requirements of plants and the mechanism of drought resistance in plants.

The panel consisted of Dr. Howard Joham, Professor of Plant Physiology, Texas A. & M. College; Mr. Chester Jaynes, Graduate Student, Texas Tech College; Mr. Earl Staten, Golf Course Superintendent, Wichita Falls, Texas. Dr. J. R. Watson, Jr., of Toro Manufacturing Corporation, Minneapolis, Minnesota, served as moderator.

Questions and the answers given by the panel members were as follows:

1. Is it possible to apply too much water to bermuda, assuming that proper drainage conditions exist?

Answer: Yes, even with ideal drainage conditions it is definitely possible to apply too much water to bermuda or any other turfgrass. Greens that are soaked and kept wet at all times create a number of problems, such as retarded root development which results in weakened plants, plants that are more susceptible to disease, insects and other damage. There was definite agreement amongst the panel members that the push button age of water is not yet a reality; that it would be impossible to eliminate the human element from a sound watering program, particularly for the greens.

2. Because of poor physical condition, many superintendents (generally at the demand of the players) overwater in order to make the green soft enough to hold the shot. It is recognized that such a practice is injurious to the grass, yet it is a reality, so what can be done about it?

Answer: This statement is very true, and the problem is well recognized throughout the country. We also recognize the necessity for a sound watering program if the green is to be good. The most satisfactory solution would be to insure a good physical condition coupled with the proper aeration, fertilization and watering program, will usually result in a resiliant green which would hold the shot and hence obviate the necessity of overwatering.

3. Is it possible to reduce the total amount of water required to maintain a good green by using an Aerifier?

Answer: Yes, any method which permits more efficient water infiltration and which promotes deeper root growth will quite naturally reduce the total amount of water required for adequate turfgrass growth. Aeration opens up the surface and, therefore, permits better water infiltration. The resultant depth and more prolific root growth enables the plant to draw on a larger volume of soil for water and nutrients and thereby permits more efficient utilization of the water applied, consequently reducing the total amount needed.

4. Is there a definite relationship between oxygen and soil water, and is this relationship as exact as say, an automobile carburetor in which a proper mixture of gasoline and air are necessary?

Answer: Yes, there is a definite relationship between soil, oxygen and water; however, it is not as exact as a mixture of gasoline and air in a carburetor. Plants have the ability to grow under rather adverse conditions and we are indeed fortunate that such an exact relationship is not necessary. It has been pointed out that when water occupies more than two-thirds of the soil pore space, difficulties caused by lack of oxygen will occur. Similarly, if water occupies less than one-third of the pore space, plants may suffer from a lack of water. It has often been said that the ideal soil for the growth of turfgrass plants is one that contains approximately 50% solid materials, 25% air space and 25% water space. While this is the optimum, we realize that seldom does this condition obtain and certainly it is not a static situation. Plants, to remain in a healthy condition, must carry on respiration which utilized oxygen and if inadequate oxygen is present the plant obviously cannot perform its functions too efficiently.

3. Why do turfgrass plants often wilt during mid-day, even though the soil appears to have an adequate supply of moisture?

Answer: Plants may wilt under these conditions because of their inability to absorb sufficient water. This is caused by excessive transpiration, particularly when temperatures are high, humidity low and excessive wind movement prevails. There is a possibility that the soil might contain too much water. Often we see a green that is practically saturated and yet the plants will wilt. This happens because the plants simply cannot assimilate water as fast as it is being transpired. Oddly enough, the solution for such a situation, even though the soil is completely saturated, is to syringe or sprinkle the green.

6. Is it necessary to water warm-season grasses during the winter time when they are normally dormant?

Answer: Yes, often watering during periods of extreme drought in the winter time will prevent severe loss of turfgrass. Plants, even though they are dormant, still carry on some metabolic acidivity, and particularly if temperatures warm up sufficiently to cause some growth and if the soil is frozen, they cannot obtain enough moisture to offset transpiration; hence, they are "winter killed".

7. In South Texas, we often experience a rapid drop in temperature, often as much as 30 degrees in eight or ten hours. Is the moisture content of the green during these periods of rapid temperature drop important and if so, what moisture content would you recommend?

Answer: Definitely the moisture content will influence the ability of the grass to survive under such conditions. Ideally, the soil should contain some moisture, probably nearer the moisture content at field capacity (this is the level of moisture that remains in a well drained soil some 24 - 48 hours after a soaking rain.) There are two reasons for this: (1) As water freezes heat is given off. The roots in contact with the water as it is freezing absorb heat and often are prevented from freezing; (2) If ample moisture is present in the soil and in the plant, there is an increase in the carbohydrate content of the plant; hence, the freezing point is lowered and chances for freezing of the root are reduced.

8. What is the relationship between a gradual drop in temperature and a rapid drop in temperature, insofar as plant survival is concerned?

Answer: Rapid drops in temperature are much more severe on turfgrasses than gradual drops. This is true because if a plant is subjected to a gradual drop in temperature the plants are able to "harden off". This process is believed to be associated with a change in the plant proteins. If the temperature drop is rapid the hardening off process cannot take place normally and the plants therefore are killed. Snow cover is very important in preventing excessive winter kill; in areas where the snow piles up to a depth of ten to fourteen inches or greater, it acts as an insulating agent and helps to bring about these hardening processes. Then, even if the snow melts, the plants will survive because the hardening process has taken place and they are in a better condition to survive adverse conditions.

9. When frost occurs on golf greens, is it better to permit the frost to disappear naturally or would you recommend removing the frost by sprinkling? On some occassions when I have removed frost from my green, the temperatures have been such that ice forms. Is it better to have the ice or the frost?

Answer: After considerable discussion, the panel recommended that frost be removed by sprinkling, even though ice were to form following the application of water. It was felt that the frost should be removed as early in the morning as possible, and that player traffic should be kept off the green until all evidence of ice were removed. There was definite agreement that frost injury was more severe than ice damage.

10. Why is it recommended that dew be removed from the greens early in the morning? And what is the best method of removing dew?

Answer: During the night plants exude certain materials which will be conducive to the development of disease organisms. It is felt that if the dew is removed these materials will be diluted to the point where they do not create a problem. Dew may be removed by poling, by dragging with a hose or by sprinkling. Too, there is a cutting problem involved when grass that is heavy with dew is cut. This tends to load up the basket and brings about improper functioning of the cutting equipment. Dew removal is certainly a more critical factor during periods of the year when conditions for the development of disease are more critical.

11. Would you recommend cutting the green it the grass is just beginning to wilt?

Answer: Definitely not -- grass should be cut when it is in a normal, dry, uet turgid condition. In other words, when the grass is just beginning to wilt and when the grass is heavy with dew are the two extremes when gold greens should not be cut if at all possible. Mechanical damage from cutting machinery is much more severe when the grass is in a semi-wilted condition.

12. Is it better to cut wet grass, or should one wait until it dries?

Answer: Don't know if it is any better to cut when the grass is dry or wet, but it is a lot easier to cut dry grass from the standpoint of loading up the basket, or even clogging up the machine. In addition, you get a much smoother cutting job if the grass is dry. If disease is present, it will certainly be spread much easier when cutting wet grass than when grass is dry.

13. Is it better to apply two inches of water at one time, or would you recommend putting on a half-inch of water four times?

Answer: It depends entirely upon the physical condition of the green and the ability to get the required amount into the soil. If two inches of water are needed to wet the entire root zone, and if this two inches of water could be applied slowly enough so that the soil would absorb the entire application, then it would be recommended that the two inch application be made. If, on the other hand, water begins to run off after an application of only a half inch of water, one certainly should not continue to apply moisture. The most important considerations in a sound watering program are to apply the water slowly enough so that the soil can absorb it, to cut the water off if it begins to run off the surface, to reapply the moisture if the entire root zone is not wet. This can be determined by the use of a soil probe. Also one should apply moisture whenever the grass begins to show signs of wilting, irrespective of previous applications.

14. If a green is sloping is it possible to water the top of the slope and then permit the run-off to take care of the lower sections, or would it be necessary to water the bottom section of the slope as much as the top?

Answer: Again, if the physical condition of the soil is such that water is absorbed very readily and if no surface run-off is permitted, then the entire green should be watered uniformly. As a general rule, the high spots on greens suffer more from inadequate watering than do the low spots because when the moisture does not go into the soil freely, it will run off the upper areas and accumulate on the lower areas. If such a situation as this exists on the green, then it certainly would be advisable to adjust watering practices in order to avoid this situation. Again the use of a probe to determine moisture penetration on each area would be advisable. Appropriate action, even if it involves hand watering on the high areas, should be taken if the moisture is not uniform.

15. Will light,shallow watering tend to bring the root systems to the top?

Answer: This depends entirely upon the soil moisture situation. If light waterings are sufficient to connect the water already in the soil system with that which is being applied,light waterings will not affect rooting, providing such a practice is not followed to the extent that the soil is saturated. If the light watering does not connect the soil moisture, then definitely you will see a concentration of roots near the surface, because this will be the only soil area from which they will be able to obtain moisture. Roots cannot penetrate a dry layer of soil and for this reason one should always water in a manner that would insure complete connection with the sub-soil surface moisture.

16. What is the relationship between good drainage, poor drainage, water logging and shallow watering applications?

Answer: Poorly drained soils may often be water logged more or less permanently by frequent shallow watering. Well drained soils, on the other hand, would require more water applied more frequently before a water logged situation would become semi-permanent. Of course, even on a well drained soil, if a water logged condition were permitted for an extended period of time, the good physical condition of the soil would probably be destroyed. It should be remembered also that even under water logged conditions, light sprinkling often is necessary in order to avoid wilting (brought on by excessive transpiration, as well as lack of oxygen in the soil), particularly during hot summer days.

17. I have often observed that during a temporary water logged condition brought on by excessive rainfall our grass scalds. Would you please discuss this situation?

Answer: Scald is related directly to excessive transpiration and the inability of the plant to absorb sufficient water to offset this problem. If the soil is temporarily water-logged, naturally the air space is almost completely occupied by water and there is a reduced amount of oxygen in the soil. This prevents the plant from functioning properly because it cannot absorb sufficient water. Again the answer, even though the soil is temporarily water logged, is to syringe or sprinkle the green. This will tide the plants over until the excessive water has been removed by natural means. Scalding is, therefore, caused by excessive transpiration and can be prevented by syringing.

18. Would the use of lime help correct such a temporary situation?

Answer: Calcium (lime) does aid in preventing excessive drying out of leaf cells. Lime also improves the soil structure indirectly; however, under a temporary situation such as we are discussing, this second function of lime does not relate directly to the problem. Plants growing on soils adequately supplied with calcium would tend to remain turgid longer than would soils low on calcium. It would appear that if the grass were dry and if one were to use a readily available form of lime, such as hydrated, this might tend to reduce scald. Ground limestone being much more slowly available would not help a great deal. The plants could be burned by the quickly available form of lime unless they were dry.

19. A while ago it was mentioned that aeration was one method of improving improper drainage. If a person does not have an aerator, could a spiker be used to correct this problem?

Answer: The use of an Aerifier or a spiker to correct improper drainage would depend entirely on the condition bringing about improper drainage. If surface compaction or layering to a depth of two - three inches were responsible for improper drainage, it could be corrected by either the Aerifier or the spiker, providing the spiker would penetrate to the depth of five - six inches or deeper, then obviously surface aeration would not correct this situation. Tiling, or French drains would be necessary to improve this deeper situation. Spiking would be particularly advantageous if surface crusting were responsible for improper infiltration of water. On some greens aeration and spiking to correct layering and surface crusting would be advisable. In direct answer to the question, spiking would substitute for aeration providing the problem were improper infiltration of water because of surface crusting or layering in a zone that could be reached by the spiker.

20. Actually I was referring to improper drainage caused by layering resulting from non-uniform topdressing materials.

<u>Answer</u>: Aeration would be recommended first to correct this situation. Some of the layering near the surface could be penetrated by spiking and this would be advantageous, but it is doubtful if results would be comparable to those obtained from aeration.

21. What is meant by the terms "drought resistance" and "drought tolerance"?

<u>Answer</u>: Drought tolerance refers to the ability of a plant to grow under low moisture conditions. Sometimes structural mechanisms within the plant itself enable it to obtain moisture where other plants could not. There is no direct accumulation of moisture within the plant and, therefore, the drought tolerant plant would probably die under extended drought conditions. Drought resistance refers to the ability of a plant to survive under long periods of drought. The drought resistant plant may not necessarily (usually does not) remain green as long as the drought tolerant plant. The drought resistant plant will go dormant and yet will exist until moisture is available, at which time it will green up. Drought resistant plants then are those able to survive without a constant moisture supply, whereas drought tolerant plants will stay green under very low moisture conditions, but cannot stand extended drought.

22. Would you please list some of the drought resistant turfgrass plants that we use in Texas?

<u>Answer</u>: Bermudagrass is both drought tolerant and somewhat drought resistant. Buffalograss is probably the outstanding example of a drought resistant grass. It will turn brown much earlier than bermuda when moisture becomes critical; however, it will survive over a much longer period of time without moisture than bermuda. Ryegrass is an excellent example of a grass that is not drought resistant. Zoysia is said to be drought resistant; yet it is not nearly as drought resistant as buffalo. St. Augustine carries very little drought resistance or drought tolerance. Perhaps it should be mentioned that St. Augustine is quite cold tolerant, but not very cold resistant, whereas bermuda carries very little cold tolerance, yet is quite cold resistant.

23. Can buffalograss stand traffic under shady conditions?

Answer: Buffalograss will not stand the traffic that bermudagrass stands. Buffalo is very fine leaved; yet it does not develop a particularly dense turf.

24. Will buffalograss grow under shady conditions?

Answer: Buffalo is not considered a shady grass. It might survive under limited shade, but it would never survive very heavy shade.

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WATER IN RELATION TO PLANT GROWTH

Chester Jaynes

I am grateful for the opportunity of talking to you about the turf work at Texas Technological College. Our work has been in progress for only a very short time and our findings are somewhat limited, but we have made a few observations and these I will report to you.

The turf plots we have established and the turf work planned for the future grew out of the realization that we needed more information on the growing and management of grass for lawns, parks, cemeteries, athletic fields, and other areas than we could obtain from a study of experimental work done in other sections of the country. We felt that if we were to give good sound advice we would have to solve some of our problems ourselves and we would have to solve these problems in our own area. The person responsible for the establishment of our turf work is Mr. Elo Urbanovsky. He had the vision, the idea. He saw the need and proceeded to do something about it. Also, I should like to say that we were very grateful for and certainly do appreciate the support of Mr. Frank Goldthwaite. He made the establishment of turf plots at Texas Tech possible.

Basically, our turf problems are not unlike those found in other areas where bermudagrass is grown. We would like to find a better strain, a superior strain of bermuda, one that will remain green over a longer period of the year than any we have now. We want a bermuda that will withstand wear and tear, recover rapidly, and yet permit us to conserve water. However I well remember Dr. Watson's comment on the possibility of finding a bermuda that would remain green well into the winter months. He said that it simply was not the nature of the plant to remain green during the winter. This statement, I strongly suspect, is just as true as it can be, and while we should continue to look for and develop, if possible, strains that will remain green longer than those now known, we need to pay more attention toward management studies wherein we might discover that handling the grass properly would prolong the vegetative period. It may be that in our area we can prolong the growing period somewhat by the proper use of nitrogen fertilizers. We have made no scientific investigations in our area on this particular subject, but we have observed that some of our fertilized plots retained their color a week or two longer in the fall than the common bermudagrass on the campus. Our plots were fertilized rather late and that part of the campus under observation was not. Bermudagrass is the best grass we have for all around use on the Southern Plains. There may be others just as good, but they have not appeared on the scene.

Another aspect of the turf problem on the plains arises from the necessity of conserving water. Perhaps the conservation of water is our Number One Job. Right now it looms larger in our thinking than any other phase of the turf picture. We know that our progress in Lubbock and the Plains area depends upon water. We urge the farmer to save water. We have through the formation of the High Plains Water District, a means of getting this job under way, at least in part of the region. But what should be our attitude in the cities and towns of the High Plains? The answer is obvious. We need to conserve and waste less water in our cities as well as on our farms. The time may come when the people of Lubbock and the surrounding area will say to us, "You tell us that we can save water. You tell us that through proper management practices we can have better lawns with less water. Well, show us. Give us the information". You realize, of course, that we are obliged to irrigate, no water, no grass. We have been told that our grassed areas, our lawns, are very beautiful in July and August, but we use tremendous quantities of water.

Our first grass plots were established by Mr. Mark Gosdin, who obtained some bermuda strains from Texas

A & M College. During the summer of 1952, he planted T-11, T-35A, T-57, T-8, T-47, T-48, U-3, B-12, and some from other areas, plus a few strains obtained around Lubbock. These were placed in a small nursery and have been under observation ever since. At the end of the 1952 growing season, it was noted that T-35A, T-47, T-94, L-2 and L-6, were the best from an all around standpoint. U-3 and B-12 in our area up to now have not been satisfactory. They are not as good as common bermuda. We have not treated them in any special manner. With different management practices they might show up better. Generally, the very fine bermuda's have been a disappointment. In 1952 Mr. Gosdin made several selections of bermuda in McKenzie State Park. One of these was L-2 and it is most promising.

During the summer of 1953 we began the establishment of several bermuda's, common, T-35A, T-47 and L-2, plus K-31 and a buffalograss, in experimental plots in order that we could start work studying the amount of water that is going to be required to produce a satisfactory turf in our area. This year we are going to apply water at different rates to these plots. Eventually we hope to have information to guide us in making recommendations for proper watering. Toward the end of the growing season of 1953, while we were making observations, we were greatly surprised at the performance of what we thought was T-35A. When we examined our records, we found that what we thought was T-35A was actually L-2. This strain in texture is about like T-35A. It is quite aggressive, covers rapidly and competes well with weeds. We found less weeds in our L-2 plots than most of our other plots. We were somewhat disappointed in T-47. It has not been under observation very long in Lubbock. It does not overcome weed growth very quickly, at least not the first year. It may be that in another year or two we will change our minds. At least we have an increase block of T-47 in case this strain works out best for us. The fact that we do not want to overlook is that L-2 was selected in our area and just might be best adapted. It probably is.

This year, Mr. Gosdin hopes to get started with a mixture study. He intends to use 5 cool-season and 5 warm-season grasses in various mixtures or combinations. The purpose of this study, of course, is to see if we can find a cool-season and a warm-season grass that will grow together in lawns or in other areas to the end that we may have green grass practically all year.

We have under observation K-31, several zoysias, St. Augustine, Merion bluegrass, K. R. bluestem, centipede, curly mesquite, plus several other bermuda's not previously mentioned taken from areas around Lubbock

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WATER IN RELATION TO PHYSICAL CHARACTERISTICS OF SOIL AND SOIL FERTILITY

Panel: J. B. Page, Bob Shelton, Gordon Jones, W. E. Zimmerman.

Moderator: Fred V. Grau

Grau: In the discussion of water in relation to physical characteristics of soil and soil fertility, I think it is important first to outline some of the basic considerations of what we are talking about. First, What does water do to soil? Dr. Page, would you discuss that question?

Page: All of you are aware that water is needed for plant growth. In that respect water is beneficial. I wish to emphasize another aspect about water, and that is its effect upon the soil. Water causes soil structure to break down. Traffic is a factor in destroying soil structure only when the soil is wet. An excess of water in the soil has other detrimental effects. It causes a reduction of root growth and root function, too. In the absence of oxygen (which is what we have when we have water standing in the root zone) the roots stop functioning. They cannot take up nutrients regardless of how well you fertilize. Roots are almost as sensitive as animals in that the minute you cut off the oxygen the root is going to be permanently injured and will probably die. What does that mean in terms of turf production? It means that in many cases we may be over-watering. We should keep in mind that our root environment must have both water and air available at all times.

Grau: That was a good send off, Dr. Page. Gordon, would you follow it up with a brief discussion of what water does to the physical structure, the particles, and its relation to the lack of oxugen Dr. Page spoke about?

Jones: Soil can be assumed to be about 5% organic matter, 45% mineral matter, 20% air and 30% water. The relationship between air and water is such that as the water increases the air decreases and vice versa. Structure of the soil is simply the arrangement of the particles. Structure is all important. There are three different types of soil water. Capillary water is the water available to plants, and in this case the structure becomes very important. Granular soil structure greatly increases the number of miscroscopic pore spaces in the soil which makes possible the capillary action. When you granulate the soil you improve its moisture holding capacity. In turf we have several things that affect granulation adversely. The most important is traffic. We may start out with a pretty good soil mixture, and then we turn the boys loose on it and the first thing we know the top of the soil is compacted, and we get the condition called puddling. This means that the granulated particles break down into smaller particles. When you get puddling you lose air space or pore space and make it more difficult for water or air to move down through the soil.

Grau: That is very good, Gordon. Bill, would you like to add anything to that?

Zimmerman: Where you men are constructing your own soil profiles by addition of sand, you must have the sand mixed with other materials in a top-dressing. Some use a 2-1-1 or a 1-1-1 mix. That is the proportion of soil, sand and humus. The more humus we add to the mixture the greater water-holding capacity we have. As the turf becomes older you have to do certain things to improve the condition of the soil and allow moisture to get down into the root zone. Along with this, drainage in the root zone is important. On the older green you may run into an impervious layer that causes trouble. We have various methods whereby you can get moisture through these layers. The movement of water from surface to root zone carries fertilizer into the soil, particularly those that are soluble in water. This also has a direct bearing on the amount of water applied. You have to work out a formula for watering because overwatering wastes a lot of fertilizer. Loosening up the turf to work coarser materials into the clay type soils, and breaking up layers are part of the general improvement program.

Grau: Bob, we would like your comments on the practical end of it.

Shelton: I would like our panel to give us some information concerning the use of highly soluble fertilizers--their advantages and disadvantages in relation to our water program.

Page: I will make a couple of brief comments on that. It is commonly believed that if you fertilize crops you will increase the water requirement. You generally believe that is true of grass. Does well-fertilized grass use more water? It may use more water but only because more growth is produced. However, I think you will find if you look at the data that the water that is used more efficiently.

The other thing I have just mentioned -- getting back to irrigation -- it has been demonstrated that water saturated soil makes otherwise available nutrients unavailable. Either the roots don't get to them or else when the roots do get there they are not able to absorb the nutrients. That has been very striking in many field crops and I am sure it has shown up in the case of turf too. Usually it is thought to apply chiefly to potash, but it applies to phosphorus and nitrogen and calcium as well.

So if we have compaction, we have overwatering, and it may be that we are not using the fertilizer elements that we are putting on. By proper physical management we can increase theefficiency of the dollar we spend for fertilizer. In many cases our growth is limited not by lack of fertilizer but lack of favorable physical conditions. You must have those first before fertilizer will start to really pay off. Then the form of the fertilizer, whether it be in a dry granulated form or in a soluble form, would make no real difference. You must have the proper physical conditions of the soil in order to get the most out of any fertilizer. Too often we have looked toward fertilizer as the answer to all our problems. Certainly it is important, but you have to do a good job on these other things as well.

Question: How does rainfall affect fertilizer needs? In the areas where you have heavier natural rainfall, does that cause you to fertilize more?

Jones: To certain limits I think the answer would be yes. Where you have considerable leaching, you will lose plant nutrients because of heavy rainfall. In general, in East Texas the normal rainfall would not be too important. But if you have good drainage in a green, the irrigation water may be flushing the plant foods right enough. You might have to fertilize quite a bit more to compensate.

Question: Are losses from leaching greater with organic or inorganic fertilizer?

Jones: We have had quite a bit of experience with organics versus inorganics. In general organic fertilizers are more slowly available to plants because it requires bacterial action to break them down. There are times when conditions will cause bacterial action to occur rapidly and then the organic fertilizer will break down very fact. I don't think you could say whether organics or inorganics are better or worse insofar as leaching is concerned. If you have conditions for leaching, you are going to lose some of the material. But you can compensate for it by repeated applications of the fertilizer, rather than putting it all on at once. You can use inorganic materials a light rate once a month or so.

Page: I think Gordon made a very fair statement of it. Where you have a type of material that is soluble, quickly available and likely to leach out, you can overcome that tendency by lighter, more frequent applications. I'd just like to put out a word of caution. You hear so much about the value of organic matter. For some reason or another we feel that there is something sacred about the organic fertilizer. Aside from the fact that organic fertilizer releases its nutrients more slowly, it is pretty hard to show any benefits of the organic matter you add as such. The amount is so small. When you use an organic fertilizer you are using it because you want something that doesn't leach out so readily. But when you talk about organic matter itself, it is hard to get much benefit from the amount that you add.

Question: Clear this up, Dr. Page, are you talking about stable organic matter or are you talking about active organic matter that is most effective in granulation and aggregation?

Page: To a certain extent about both. I'm just raising the question in your minds as to whether or not the amount of organic matter you add out of the bag will give you very much of either active or stable organic matter. It is very small in proportion to the amount you get from the roots under a good bermudagrass sod.

Question: What about clippings dropped on greens?

Jones: It is better to take clippings off greens because they are a hinderance to the putting surface. On fairways where you are getting a lush growth and you keep letting the clippings fall back on the surface, eventually you develop quite a matted condition. There comes a time when accumulation of clippings can be quite detrimental.

Grau: I think that has been satisfactorily taken care of. Let's hear from someone in the audience. What is your fertility program on greens?

Answer: Right now I'm using about 50 or 60 pounds of Milorganite every 15 days on my greens. In the winter time that is the only thing I use. Any other type of nitrogen I have been unable to apply without getting some ill effect from it.

Question: Has it been your observation that where you have a denser turf you have fewer ground tracks?

Page: I've wondered, too, if we had denser turf whether it would minimize those cracks. But I think the soils that are doing all the cracking just wouldn't make very good turf. Cracking is due to the nature of the soil rather that the covering. I think you would find if you did not have cracks in those soils you would not be able to grow anything because it would be just like concrete. I can see the point of filling in the cracks so you don't lose golf balls, but not to prevent evaporation. Measurements have not shown that any more water goes out of those cracks than would go out of the soil normally. When it does rain you get a deeper penetration than you could otherwise.

Question: By a careful water-fertilizer program you might increase root growth and in turn organic matter. By this improving the granular structure of the soil would this in turn reduce its tendency to contract and expand?

Answer: We did some work of this kind in another state and where you have soil improving crops the soil didn't appear to crack as much.

Question: Would it be of any value to put fertilizer in those cracks so when they did close up there would be a tendency for roots to go down to the fertilizer?

Page: It would take a pretty high rate of fertilizing.

Question: What would dynamite do to soil cracks--half a stick in each crack?

Page: Some of the soil I worked with would just shoot up into the air. I don't see that you would accomplish a great deal by doing it--you still have a soil that cracks. That is the nature of the soil to do that until you get it broken down and get some organic matter in it.

Question: What about soil conditioners?

Page: Soil conditioners do a job of stabilizing but they only stabilize what is there. You would have to break the soil down and get it into ideal condition and then put on the soil conditioner.

Grau: What is the next topic? I think that subject was pretty well covered.

Question: What can I do about sand layers in my greens?

Page: I'm not a golf green man, but it seems to me the practical thing you could do without tearing up the whole green would be thorough aerification to allow materials other than sand to go down into that area.

Question: Where we keep soils continually wet would it be beneficial to let them dry out occasionally?

Page: There are two advantages of letting the soil dry out as far as you can. A big part of our structure is brought about by drying. Drying seems to be one of the best ways to get soil to shrink and crack along the root channels, and it is probably one of the best ways we have to induce better soil structure. Moreover, if the soil dries out at the surface the roots tend to go down. You can increase the root system tremendously by letting the soils dry out.

Question: What is the food value of barnyard manure?

Page: I could only give a very general answer because the food value varies with the age, the way it was stored and everything else. Ten tons of manure would give you about 100 pounds of actual nitrogen.

Grau: I think we have had a wonderful session, thanks to the interesting discussions your questions have brought from our panel.

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WATER IN RELATION TO THE ENEMIES OF GOOD TURF WEED, DISEASES, ALGAE, SCALD

O. J. Noer

All of you are interested in the finer leaved bermudas, especially for greens. South Florida is rapidly changing over to fine texture bermuda because they cater to the Northern yankee in the winter time. Most of our northerners are not accustomed to playing on anything as coarse as bermuda. They know how to putt on bent greens so the use of the finer bermudas in Florida is an attempt to provide these visitors with something more like they are accustomed to in the Gene Tift, which is a selection made from some greens at Bay Shore, has been used in that area eight to nine years or more on several of the courses. In that area Gene Tift has established its place in life. Fred Hoerger who was in charge of La Gorce and Bay Shore used African bermuda on greens at both courses many years ago. He planted them to African bermuda because it was on a finer textured grass more compatible with the rye they used for winter play. He had to abandon the African bermuda because under close cutting it would not resist invasion by common bermuda. Any fine-leaved bermuda which is to be used on a green has got to walk into common bermuda so to speak rather than let the common bermuda take it over. After African bermuda failed twice, Hoerger went back to common bermuda and as a result of the natural crosses that he had developed he began making selections from the greens. Gene Tift, who was the foreman at Bay Shore and who took charge after Hoerger died, continued to care for the selections and planted the best one which was called Bay Shore in Texas. It is known in Florida as Gene Tift.

The greens at Indian Creek, at Miami Shores, Plantation Club, Lake Worth, Miami Country Club are of that strain of grass. At Palm Beach some of the greens at the Everglades Club, and one or two of the greens at the Florida East Coast Course are of the so-called Everglades 1 selection, a selection sponsored by Roy Bair when he was at the Everglades Sub-Station in South Florida. It's a similar grass of fine texture but its habit of growth is a bit different. Everglades 1 has performed well. Then, of course, many years ago Hall at the Savannah Club in Georgia made some selections of superior bermudas from his greens. Along with that we have the grasses developed at Tifton by Dr. Burton and Robinson.

Tifton 57 was the earliest and best performing selection from the standpoint of growth characteristics. It resists leaf spot and most of the common diseases. Its ability to withstand the shock during the transition period from rye back to bermuda is almost unbelievable. It has everything except player acceptance. The turf looks good always, but the grass tends to puff on the green and make for bad putting. Burton crossed Tifton 57 and other selections with African bermuda and developed a number of finer textured bermudas. The selection designated 127 and called Tiffine is one of the best crosses. It looks good except it seems to produce many short seed heads. This stemmy type of growth is not liked by the golfers. Gene Tift does the same thing but the period isn't long and occurs at about the time the grass would like to produce seed. Last night I showed you a picture of the T-35A, which is a Texas selection. It looked awfully good to me when I saw it at Los Angeles. Many of you in the area where the growth of bent isn't feasible are going to come to the use of a finer textured bermuda. I am of the opinion that the cost of maintenance for fine bermuda isn't going to be any more than the bermuda-rye grass, ryegrass-bermuda which is used now for summer and winter play. You will not have the difficult transition period. If these greens are over-seeded with a winter grass I don't think rye should be used. Ryegrass is too coarse in texture to make a decent combination with the finer textured bermudas. You will go to red top or possibly common Kentucky bluegrass for these associations. The greens at Miami Shores have no winter grass seeded in them. I am confident that these grasses are winter hardy in many places because Gene Tift has withstood several winters in Charlotte, North Carolina and in Nashville, Tennessee. I don't think you have more severe winters than they do up there.

When you start to use these grasses it will be necessary to treat them a bit differently. You can't top dress heavily like you do with common bermuda because heavy soil cover smothers the grass. There will be a little bit more thatch as shown last night but by cutting close and by using the comb in front of the putting green reel may be enough. If it isn't, you can use the verti-cut or some other similar implement to keep thatch under control. Feeding habits will probably be a bit different. We like to give common bermuda plenty of fertilizer. These grasses need plenty too. But with the fine leaf bermudas it is better to feed more often at lighter rates each time. So with these few preliminary remarks we'll go on now with the formal part of our program. Are there any questions anybody wants to ask about my opening remarks?

Question: Are any of these minor grasses resistant to freeze in cold weather?

Answer: Charlotte, North Carolina gets freezing weather every winter. The Gene Tift strain has survived up there. As a matter of fact some of the new selections will hold their color even when temperatures get quite low. After going off color they snap back quite fast when the weather becomes favorable for proper fertilizing will help them to keep their color. Keep the fertility level adequate with the approach of winter and then the grass will stay green for a longer period. Of course, it isn't going to be green when you have ice on the ground.

Noer: Fertilizing also affects greens with respect to stemminess. What we get them to do at Dunedin and also in South Florida is to emphasize nitrogen during the period that grass normally tends to become stemmy and to ease up on the potash at that time. Emphasize potash, which the turf must have, at the time when grass is naturally vegetative.

Noer: Well let's get back to our program theme, water as an enemy or good turf. Bermuda will tolerate more water than bent, but will behave better if water is properly managed. I've got to get old man Crain out of my hair by letting him show his pictures. I think he is getting to be a better photographer than he is a grass grower. Albert, go ahead.

Crain: In this particular case I would not attempt to grow the grass. Water is the enemy here. The green has settled and water stands on it. You can see the evidence of water damage. The green is in perfectly good shape today. Sod was taken off and the low area raised.

This is a green that behaved badly until the tree that kept the surface shaded was eliminated. And now it is a perfectly good green. Trees affect soil water besides producing shade. The roots of the tree in the green deprive grass of needed water.

Here is another green that is going to cause more trouble than any other green on this particular golf course because of its location. I don't see how air could move across this green.

Grass won't grow in areas like this until the salt condition is eliminated.

The fellows at Houston can say that this grass really gave trouble in 1952-1953. It was a wet year and so this is easily directly related to water. You see the color here. The brown appearance on the leaves is from leaf spot. Two or three courses lost the greens from leaf spot. George Aulback really got a good welcoming into the Coast area. He hadn't been in Houston three weeks until his greens all looked like this. Leaf Spot was devastating and wiped out the grass cover. These greens had heavy mat, altogether too heavy. But the mat was gone after the disease killed all the top growth. I expected 50 baskets or more of dead grass were taken off each green. The Verti-cut machine was used and then it was mowed, and then it was Verti-cut again and the leaf sweeper used to take off the vegetation. After it was cleaned up it was aerified thoroughly. There was a lot of silver crab present, so a good application of sodium arsenite was put on to kill the silver crab. Within a week the next picture was made, so you see how rapidly the grass recovered. This picture was made on the 15th of July, the other one was made the 8th. They show the quick recovery after the severe treatment of cutting all grass absolutely off to the point where there was no bermuda grass left on the surface.

Here is another thing you fellows want to know. The streaks are the result of poor distribution of fertilizer. That may or may not be one of the problems you have to contend with. Here is leaf spot disease again that is a result of using the wrong type of fertilizer and the way it was used to kill weeds. In Musser's book TURF MANAGEMENT it states leaf spot disease is associated with too much nitrogen. Statements of any kind are not made in a text book until they know for certain that they are facts and the statement reads this way not only in TURF MANAGEMENT but in the turf disease bulletin as well. Quickly available forms of nitrogen fertilizer are directly associated with severity of these leaf spot diseases. This is a good illustration of the leaf spot disease.

Here is scald. This is nothing more than fungus growth that is a direct result of too much water. Maybe he didn't put it there but rainfall came and did it. Too much water is the direct cause of this scald. This is a case where too much water was put on the greens by man. It was in San Antonio where it hadn't rained enough to get the greens wet. The scald actually killed the grass. Back 15 feet beyond the green the bermudagrass was quite good. In this picture the scald is one-eighth of an inch thick. The grass is trying to grow but it is actually being smothered to death.

Here is a different condition yet try to find the disease or insect that is responsible. It is iron chlorosis. We don't know what caused it, but it occurs on that green every year to some extent. Just why we don't know. The yellow color is characteristic of chlorosis.

Well I think most of you recognize what this is but if you don't you better get to where you recognize it and get ready to do something about it, because there is Rhodesgrass scale.

This is a different situation. This slide illustrates two things. I think you can see the streaks. Don't ask why the streaks occur. I'll give the answer O. J. gave awhile ago about the disease organisms. It doesn't look like leaf spot when it occurs in these streaks this way, but that is what is doing the damage. The other thing that this picture shows is scalping. This particular green is not level.

To talk about enemies of good turf in relation to water, here is water-induced nutgrass. This is a practice green that is grown up in nutgrass. The green in the next picture received a lot of sawdust five or ten years ago. They didn't have much luck with the greens for many years because they used too much. What is the value of sawdust on greens? It is a source of organic matter. If you use sawdust you must apply enough fertilizer to offset the high carbonaceous sawdust.

Noer: Thank you Al, everybody appreciated it. I'm going to have John Darrah show you a couple of pictures. Before you do that I just want to remark about the scald which Al brought up. So called scald is caused and induced by algae. Algae are present in all soil, everywhere. So long as you have a good dense cover of turf to shade the ground there will be no trouble from green scum or from algae. But the minute that anything happens which thins the grass enough so the soil is exposed to light and the surface gets and stays wet from too much water applied by you or by rain, a green cover of algae will spread over the bare area. Then it will turn to a black scum-like covering which seals the soil and retards recovery of the grass. When that happens elsewhere, and I am sure it will work here, what most of our men do is to put a little dry hydrated lime, anywhere from two to five pounds per thousand square feet. Usually it is applied in the afternoon and left on the surface until morning, not watering then. The hydrate drys the surface and kills the algae. Then the black scum-like cover disappears. That is about the best thing to do if you get into that kind of trouble. You know that hydrated lime is used in mortar. It will take up water. Therefore if you use a little hydrate you will dry the surface and you will stop the growth of algae. John, take the floor.

Darrah: Well, this is a picture showing why silver crab is called silver crab. You have a lot of wear and tear and a lot of excess water as probable reasons. The next picture shows the control with a mixture of 2-4-D and PMAS. I suppose there are a lot of other things involved in selecting a control treatment. Here they wanted to get rid of everything and follow with reseeding.

This is crabgrass control at Rhode Island showing the crabgrass in the check area. Along side the area of control with PMAS they used one ounce per thousand square feet weekly throughout the season. But at the same time they obtained leaf spot control in this area of bluegrass. There is one case of a pint of PMAS per thousand square feet.

This picture shows the effect of excess watering. The high temperature and humidity is causing the big brown patch. Note the smoky ring on it and algae where grass is thin.

Jim mentioned Gene Tift Greens. After play stops at Indian Creek in Florida they let the grass grow on greens until September. Then they cut everything and get ready for the winter season. This practice also eliminated an awful lot of the Rhodes scale. Of course it saves money for the club, by not cutting all summer. This picture shows you about as much growth as Gene Tift will make if it is not cut.

In the Florida Area this could be a nursery. They simply take everything off to the ground and use the top materials for planting purposes. Then they let it grow back again. They cut and fertilize the fairways all summer even though there are no players on the golf course. But they must develop good turf during the time bermuda grows at its best which happens to be when they don't have any play.

Zoysias grow so slowly we never get anywhere with them. This is a nursery in St. Louis which was never given too much attention except that it was watered occasionally. This was a four inch plug of Meyer Zoysia four years previously. It has reached from here to here and it was at least eight feet from here to there. So after the third year the zoysia certainly is pushing out and doing such a good job that it makes me wonder wometimes whether or not we have a place for it in the collars of our greens where we get a lot of wear.

Noer: I do not mean to take Scotty to task but I don't see any other mower manufacturers represented so he is the only man I can pick on. Without question, power mowers do damage on the edges and aprons of many greens. We see a lot of it on greens of bermuda that are seeded with rye. In my opinion it is a bruising action from applying power through the drum together with an abrupt fast turn that does a lot of damage to the grass. Slow your operating speeds so your men walk at a normal slow speed. Have aprons big enough so the greens man can make a big sweeping turn and you will lose less grass. Now I am going to water as an enemy of good turf. In watering bermuda, some think we can't give it too much water. You want deep roots. I have seen plenty of soil moisture but the roots just would not grow, probably because there was too much moisture. What happens when you hold a persons head under water? He soon drowns. The same thing happens to the roots.

Ed Daniel: The best way I know of to test soil moisture is the use of a soil probe. It will show depth of roots also. We should water less frequently. This summer many of you saw the greens on the golf course in Wichita Falls. They were watered once a week due to the city's shortage of water. If they had anticipated and started less frequent watering in the early spring they would have forced roots to go deep.

Noer: In other words, he believes many of you water too often and too little. But I am sure in many instances the players insist on over-watering in order to have the greens hold any type of shot. If you persist in doing that you are going to reach the point where you can't get a green to hold a shot for several hours after it is watered. It is much better to change practices not only in watering but of fertilization and to develop a good mat of turf on the green. Then player complaints about greens not holding a pitch shot will disappear. Whenever the grass begins to go off color the layman thinks it needs a good drenching of water to make it green. He forgets that there is a relationship between fertility levels and moisture content of the soil. In too many instances he expects water to do the thing that some good solid food will accomplish. We can't live on water alone and the same thing is true of grass.

Crain: That is one topic that can be talked about a long time. One of the best illustrations is one I saw recently in connection with water. We were on a golf course last Friday and O. J. thought they never used fertilizer. We talked to the greenkeeper. His records showed the greens had been fertilized every ten days.. The next day we were on another golf course where the same schedule was followed and the same fertilizer was used. Yet on the first golf course O. J. complained about the yellow grass. On the other course the greens were beautiful. The only difference was that on the first course where the greens looked starved to death, water in the cups was within half an inch of the top. On the other greens you could see no water whatsoever in the cups. Where the grass was yellow the surplus soil water had absolutely driven all the oxygen out of the soil and locked up the nitrogen.

Noer: One thing I want to get out of you, Al, is that water won't replace fertilizer and fertilizer won't do what water is supposed to do, but when both work together and other things are ideal for growth, grass performs as it should.

Now we will devote a little time to the relationship of water and its usage to weeds, to diseases and we will ignore insect pests. So John Darrah please comment on water and weeds as well as water and disease. You don't have to know too much about bermuda to know the answer to this. He came from the cool-season grass country. In a few months these warm-season grasses will do as much as we accomplish in a couple of years. Please give them the basic principles underlying the relationship of water to weeds and diseases.

John Darrah: Well, when I came in here I put the slides in my pocket because as O. J. says, we live in the territory where bent is often everywhere on the course from the first tee all the way through the fairway. We have to sprinkle and in doing that we aggravate these conditions which encourage weeds and disease. We learned the hard way that the more we water the more trouble we get. We used to sprinkle out bent fairways and saturate them. Within 24 hours, in fact the next day or evening, we come back and water the same fairway. We do that to get deep penetration of the water and avoid water standing around three or four days to bring disease in hot humid weather. The weeds come in after the disease and that is how we get chickweed, clover, etc. in our fairways, and on the greens too for that matter. So I don't know what more I can say except that there has got to be management. You must know when to sprinkle, how much to sprinkle. I see a lot of places where the thatch and mat is built up so much that when you sprinkle the water stays in that matted area which is the finest place in the world to breed fungus diseases.

Noer: As I travel around the country I find a man with fine greens, excellent fairways, seemingly no trouble. Then I may go across the road to another golf course with the same grass, same soil, and no end of trouble. You can't tell me that management isn't partly responsible for the different situations at those places. So far as water is concerned we have trouble with Helminthosporium and related diseases. Over-watering is one of the things that certainly is responsible for encouraging disease along with too much nitrogen in many instances. Most of our plant diseases, or our grass diseases, belong to the mold family. By way of illustration, as I said in the other room, you never see mold on stale bread. It is confined to fresh bread. The difference is one of moisture. Stale bread is dry and fresh bread is moist. So if we keep turf continuously too wet, and if we over-do nitrogen we make the tissues of the grass soft and it falls prey to almost anything that comes along. Sometimes disease is the primary cause of trouble but at other times disease is secondary to some of our managements factors as I said yesterday. Now I am going to throw the meeting open.

Question: This scum that is formed on the greens, would it be any benefit to use lime?

Answer: It would help a great deal. The scum is not from a fungus. The algae which caused it is actually a very simple form of green plant. But the thing to do is to have well drained greens and to keep a good thick turf. Then you won't have to worry about scum.

Question: I have five greens that grow from the water. If I would go in and use the Verti-cut and some type of Aerifier afterwards to help dry them out, would that help?

Answer: I think what you better do is move those five greens to drier places. You are going to have trouble always until you do. After using the Verti-cut the use of a little hydrated lime should help. When you take all the grass off you will have scum on the greens. Then use a little hydrate and coax the grass back.

Question: When you use lime do you water the lime in?

Answer: No, put it on in the afternoon and leave it there and water it in the morning. By that time the benefits will have occurred. The reason for putting the lime on is to dry the surface so if you put water on immediately you might as well not put the lime on in the first place. That's why it is better to put it on dry instead of spraying it on. The next morning I would water as usual.

Question: Why put the lime on it in the afternoon?

Noer: We usually do that because then the heat of the day is over. Hydrated lime is somewhat caustic, there is less damage of burning the grass with late afternoon applications.

Question: What about sand?

Answer: I guess sand will kill it but sometimes the kill is worse than the cure. Personally I don't like to use pure sand. I would much prefer to keep my soil uniform in texture throughout the soil column. I can show you too many greens that are bad as a result of following the suggestion "what this green needs is a little sand" and then a layer of sand goes. Somebody else suggested peat which forms layers too. In a couple of years your grass dies suddenly in hot weather and you wonder what has happened. I am sorry that I haven't a few soil profile pictures with me to show you the importance of keeping the soil uniform in texture throughout. Maybe you need fresh drains. Make deep holes with a posthole digger and fill them with gravel. They act as reservoirs for water and allow it to seep away gradually. You had better keep the soil on the sandy side if you are going to use those find textured bermudas, but don't change abruptly.

Remark from audience: Down here we don't put a layer of sand on a green or put clay on a fairway we have an Aerifier to mix them up.

Panel reply: If you put on sand which is uniform in character many times the Aerifier isn't going to thoroughly incorporate it with the soil. If you use a very coarse grade of sand there is much less liklihood of that happening. Possibly making the holes and stirring the soil will do more good than the use of sand afterward.

<u>From the floor</u>: I use a coarse sand almost as coarse as cement sand.

<u>Panel</u>: A variety of particle sizes is what you want when you select a sand. Don't have those particles uniform in size because they will pack much more.

<u>Question</u>: What about this Rhodesgrass scale?

<u>Crain</u>: I'd like to find something that will kill it. There is a new material that has been under test for three or four years that agriculture has proved for use. It is very definitely not as poisonous as earlier recommended materials. It has not been available for distribution but it will be available. So I'm not worrying about controlling Rhodes Scale on greens. The fellows from San Antonio have used Parathion and it had no injurious effects yet. I can say they will not have because I learned something new not more than three weeks ago about Parathion. It was believed at one time that Parathion was dangerous to the user at the time he was using it and that nobody should get any of the material on them afterward. That was stressed and stressed so nobody could recommend Parathion, if it were for sale. Several stores have had it for sale and I know for a fact that the Dow Company has had it setting on their shelves for three or four years and haven't sold any of it. They have given a little of it away. Due to the after effects on the players, those in charge of football fields will not use it. But phosphorous which is the killing agent in the Parathion completely disintegrates within 72 hours after it is used. In other words, three days after Parathion is used it is gone. In the meantime we have another material that I am quite certain will control scale. We should have it in 1954. Also, you can use a Verticut machine to remove the mat and the scale. I illustrate the mat situation this way. Diseases occur in the mat, grass doesn't like the mat because it gets killed by the mat being there. The golfers don't like a mat because when you get those runners on your greens they become rough and you get thatch, mat, and a graininess which golfers detest. But Rhodesgrass scale loves it.

<u>DuBose</u>: I took the Verti-cut and went over the practice green in two different ways. My 18 green right alongside. I didn't do anything to it. The practice green came right back. I didn't have any more scale

and haven't had it since. The places that I didn't do anything to on the 18 continued to get worse until I put rye in.

<u>Crain</u>: That practice green where you used the Verticut was similar to the slides. I showed you one where they cut all that mat off and a week later it was green and stayed that way. The machine hadn't been in Texas two weeks. We got it out and used it on the practice green.

<u>Noer</u>: Is that enouth about the scale? One of these days someone is going to come up with the real McCoy for fairways. I have faith because I can recall the time when grubs of the Japanese beetle made turf look worse in the East than plowed ground. Leach finally came up with an answer, lead arsenate, which did a job for many years. Now it is chlordane. As time goes on somebody will have an answer for Rhodesgrass scale.

<u>Question</u>: I have one thing that is bothering me on the lawn in front of the club house. They put flour to make a line to play a game. Where that flour was put down the grass is green and the rest of it is brown.

<u>Answer</u>: There is some protein in flour and that means there is nitrogen. Protein is 6.259% nitrogen so what you did was give some nitrogen to the grass. Are there any other questions?

Then let me say this in conclusion about those fine textured bermudas for the benefit of those who try it. Be sure to provide good drainage, that includes under drainage as well as surface drainage. Provide a good soil, one that is a bit on the sandy side. I would make it quite sandy so that it will move water well. The grass will make a tight turf of its own accord. The turf itself will go a long way in providing what the golfer wants so if you have the right kind of drainage and the right soil which moves surplus water rapidly it will minimize many of the troubles which you may otherwise have, such as leaf spot. If you want, put a gravel blanket underneath the green. With some of that nice plastic clay that I see in this area I would put the trench so that the tile lays below the subgrade and the gravel and the tile will take away surplus water very quickly. The tile will move the surplus water out of the gravel layer so it is able to take and move more water. I can conceive of the time when the gravel layer alone might not do what is expected of it. During a long period of continuous rain the clay base underneath would act as a seal and then the gravel layer and soil above would become completely saturated with water. The tile lines will remove water as fast as the gravel layer becomes saturated and will prevent the soil above from becoming overly wet.

Crain: Let me make one statement in connection with what you have been talking about. I've heard it said three or four times at this meeting that Crain has talked several people out of using the Gene Tift or the improved bermudagrasses. Don't use any of these improved grasses unless you drain or can otherwise get rid of excess water. If you want to reconstruct your greens, fine, but it is going to cost you a lot more if you try to put these improved grasses on a green that will not drain. So get rid of that excess water.

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SUMMARY OF THE TEXAS TURFGRASS CONFERENCE

Marvin H. Ferguson

There's always one good thing about being a program chairman; you can pick your spot. If you want to talk, you can. If you don't want to, you can leave yourself off the program. I wanted to have the last word at this conference, so I asked to be allowed to summarize the conference.

I'd like to add some words of appreciation to those Dr. Adams just uttered. This time we had more people participating in our conference than we have ever had before. We had 37 people who appeared on the program in some capacity. I want to thank each one of those people and I'll not try to mention them by name. The officers of the Association have been very helpful in trying to facilitate the working out of this program and in seeing that it was put over. I want to thank them. I want to say that Dr. Adams (while he says he is a paper pusher) certainly has done a great deal to help us carry the work on. Dr. Adams is one of the best friends of the Texas Turf Association, and he would tell you that. I want you to know it and to acknowledge the fact. I would also like to thank the audience for your attentiveness and your participation in those "questions and answers" sessions yesterday. I think that a panel discussion is not successful at all unless you do get audience participation. I know that you were interested, I know you asked a lot of questions and I think that is fine. It makes the program. It allows you to get answers to some of the things that are worrying you.

I am also grateful that this conference really has been a business-like affair. You came here for business and that has been the most important thing on your program. Your social activities have taken a second place. Perhaps that is typical of Texas A & M College. It is always more or less taken for granted that when you come here, you come for business; if you want to play, you go elsewhere. This conference has certainly been a business-like one and I think it has added to the conference. I think you have gotten more out of it for that.

This year it was decided that the conference would have a central theme and that theme would be "Water". We have talked about nothing else much except water for these last three days. Certainly it is one of our most important problems and while we can't have all our conferences centered on one subject like this one, I think it is a good thing once in awhile for us to have a conference that amounts to a symposium on one single problem. I'm sure that all of you have gotten something from the conference. Some of you have gotten more than others,but everyone must have learned something.

I'm going to go through this hurriedly. It really isn't going to be much of a summary but I do just want to mention a few highlights. If I refer to my notes frequently I hope you will forgive me. I simply must look back to see what happened next.

Dean Shepardson started off by welcoming the group to the College. Dean Shepardson is a good friend of the Association. He has been with us almost every year in some capacity. We enjoy his participation.

Then Dr. Rex Johnston started the business part of the program by talking about "Water Resources and Water Use" in the state of Texas. I wrote down one direct quote. He says, "Water is something we can't go on taking for granted". I think there is a lot of meat in what Dr. Johnston told us. I copied down just a few figures. One is that there are 37 million acre feet of water that run off every year in Texas. I think that is a rather remarkable figure. It is pretty hard to conceive of that much water, but it sounds like an awful lot of water. He says that 7½ million acre feet were used in irrigation. I don't have any idea what percentage of that was used in turf irrigation, but certainly if we could use that part that is used in turf irrigation more effectively it would amount to a considerable saving.

Mr. Ruhmann's paper followed right along and was presented by Ed Daniel. Among other things he pointed out that a third of the city's water supply, in a typical city like Wichita Falls, goes for use on turf. That is a remarkable figure. I don't remember if it was pointed out in this paper, but last summer Mr. Ruhmann said that it costs a lot of money to expand a water system. As your population grows, and you have to expand your water facilities, if you are pumping from one central plant you must go back and start expanding, the system from the center. You can't just add on to the end continuously; you must expand the size of your mains and your pumping system. It costs a lot of money to do that kind of expansion. If you can use that water more effectively, and save some of it, you can postpone the date when you have to go in and expand the water system.

Dr. Hagan followed. I would like to say again how much we appreciate Dr. Hagan's coming here. He has come a long way. We promised him his expenses if he would come and I think that is mighty little to offer. Bob, we do appreciate your coming very much. Bob pointed some things out to you that I think surprised you; they did me. He said bermudagrass on a good soil where it has deep roots can go more than three months without water, and some of us think it can't go one day without watering. I hope some of your concepts of water requirements of grasses like bermudagrass will change and that we will be able to use our water more effectively.

There are several important points that Bob mentioned. He asked the question, "How often should we water", and he supplied the answer. "We should water when the grass begins to suffer". "How much should we water?" "We should water enough to replace the water that has been removed by the growing crop and through evaporation since the last water was supplied". "How do you know how much water it takes to recharge the soil with water"? He says to use a soil probe and I hope all of you will take that to heart. I think that certainly is something you need to do. You must look underneath the soil surface and see how wet it is and how far down it is wet before you are going to know how much water to put on and whether you have put enough water on when you have decided to stop. He said we should know the rooting depth of our grasses. We should know how fast they remove moisture. It will give us a better indication of how soon we have to come back and water again. We ought to know the ability of our irrigation systems to replace that water that is removed so we know how long we have to run those sprinklers to recharge the soil with water. A good sampling tool is a must. I keep repeating that. I think it is very important.

Jim Watson came along and followed Dr. Hagan's talk. Jim's talk and Dr. Hagan's were pretty much along the same line. Much of Jim's information was gathered in Pennsylvania. Dr. Hagan's information was gathered in California. The fact that their findings jibe pretty closely is a clue to us that what's true in Pennsylvania and what's true in California may also be true in Texas, and we ought to listen to it. Jim also asked, "When do you water, how much do you water, and how do you water"? He gave the same answers that Bob did. On this question of "how much" or "how do you water" Jim expanded a little bit and said you ought to water in such a manner that your soil can take it as fast as the water is applied. In other words you shouldn't have run off. The runoff is wasted. Jim went ahead to point out some of the results of compaction as it affects water infiltration rates. He talked about water holding capacity of the soil and pore space distribution. He talked about the importance of drainage. Certainly all of us recognized the importance of those things but it is helpful to have them pointed out again.

Dr. Lewis followed with a discussion of the development of the Texas Turf Association program and the research program here at the College. He said we have progressed from nothing to something in a period of seven years. He pointed out that we have had help from a lot of sources and mentioned especially the funds contributed by the Goldthwaite Company without whose help the program could not have been continued. At the present time the program is modest but it is one that can stand on its own feet. It is a program that will allow an orderly investigation of some turf problems. Certainly they will be limited but we are in a position to go forward with a research program.

On Tuesday we had panel discussions. We had four groups and four panels and they rotated. Unfortunately, I couldn't sit in all those panels. I wasn't even in one of them all the time, but it occured to me that they were very well conducted, they were very well attended, they were very well received. There was lots of audience participation. I'm not going to attempt to summarize those "give and take" sessions where you were asking questions and getting answers.

There was one set of figures concerning this matter of water use and water cost that struck me particularly and I would like to talk about that a little bit. James Taylor was reciting some figures for Lubbock. He says that it costs $793.00 per acre to install a water system. Others have told me that that's really not a very high figure,that it is pretty conservative. He syas it costs $87.40 per year acre for water that is used in irrigation. It costs $92.00 per year per acre for the application of that water. I think those figures ought to give us something to think about because as many acres as we water around the state, this use of water gets into a quite bit of money. Anything we can do to reduce those costs certainly is going to help our turf users.

Tuesday evening we had a banquet. We didn't do a lot besides just eat and have a little bit of a business meeting afterwards. Dr. Adams did provide a few laughs with his stories. I think that is going to grow to be an annual feature, Dr. Adams.

On Wednesday morning (this morning)we have been having research reports and those are fresh in your minds. I am not going to attempt to summarize them either. I think you must have been impressed by the amount of research that is going on around the state. We admit that it is a modest program, we don't have a great deal underway yet, but I think that is what Dr. Lewis meant when he said we have gone from "nothing to something". Certainly we have got something. We are finding some answers. The Association ought to be proud of the research it has helped to sponsor and foster in this state. There are some people who deserve a great deal more credit than others. Al LaGasse and his group at Wichita Falls, the Dallas Park System, Joe Smith's work in East Texas. All of these people who have contributed to the fund of knowledge that we are gathering about turf grasses in Texas certainly deserve our thanks. I think that we are never going to have the kind of research program that we would like to have in Texas. It has been my observation that nobody is ever able to solve all the problems along any particular line and that always we would like to have more research than we can afford to have. But we are gaining some answers, we are going forward, and I think we ought to be proud of that program that is in progress.

There is one thing about Joe Smith's talk that I would like to mention and I am going to be through. He talked about new grasses and particularly T-94, which came from South Africa. It is supposed to be a natural hybrid between the African bermudagrass and our common bermudagrass. Joe mentioned that it thatches very badly. That is one of the serious problems. I think that is pretty nearly true of all of our fine leaved bermudas. They are going to tend to thatch much more than our common bermudagrasses do. That is a management problem that we have to face. It has been the experience of a good many people who planted those fine leaved bermudas they had to change their management schedule to keep those grasses in condition. These improved grasses will provide superior putting surfaces when we learn the proper management techniques, but until we learn the management techniques, we are going to get in trouble with them.

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