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F O R E W O R D

I want to express my thanks and appreciation to all those who had any part in conducting the 21st annual Texas Turfgrass Conference. A record attendance was recorded.

Special recognition is also extended to the speakers who made the publication of these proceedings possible. We trust this report will be of value in developing better turf.

George G. McBee
Program Chairman

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USE OF HERBICIDES UNDER AND AROUND TREES

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Landscape trees are valuable and should be protected from damage by herbicides. Trees are established in locations to serve a landscape function. The tree may have been set by the landowner or had a natural origin.

Safe use of herbicides under and around trees is possible if one gives consideration to age and species of a tree.

A large established tree has roots which are distributed within the top 18 inches of soil below the existing grade. The tree roots spread out in all directions to a distance equal to the spread of the branches. The trunk of the tree is protected by bark at the base. The roots are protected by the soil layer above them. There are exceptions where ditches or soil cracks occur, or if the tree is in coarse textured soils. Tree roots which penetrate flower beds may have exposure to herbicides.

Young transplanted trees or those selected to remain from natural establishment are likely to be harmed from herbicides applied to the soil or postemergence sprays because of the lack of protection at the base and shallow roots in permeable soil. All species do not respond the same to a herbicide or family of herbicides. A rule to follow is to avoid the use of herbicides in the drip line of young trees until the soil settles around the root system.

Location of the tree in relation to the weed problem to be controlled or eradicated should be considered.

Most weed problems usually occur along borders of parks, school grounds, industrial sites, and cemeteries. Eradication of these weed patches can be accomplished by use of soil sterilants. Many of these herbicides are used to control woody vines and deep rooted perennial weeds and brush. Rates of soil sterilant herbicides are higher than rates of chemicals used preemergence or postemergence. These chemicals applied near tree roots are likely to cause severe damage to the tree. Surface drainage may move the chemicals into areas in which tree roots will absorb the herbicides.

Fences of certain facilities become weedy and need attention. If high rates of persistent herbicides are employed in these areas under trees, damage is usually assured. Scattered patches of perennial vines or grasses may be problems in certain locations. Give consideration to the trees present before selecting a control measure. The user of

herbicides should be aware of when and how to use the chemicals to solve these problems. The best control under or near trees is to use either contact or translocated sprays and be careful to prevent spray drift or excess chemical from leaching into the root zone of the tree.

Herbicides which may be harmful around a tree are the growth regulators. Herbicidal selectivity may prevent certain herbicides from harming specific species but generally young growing leaves are damaged by spray drift of the growth regulators. These herbicides are usually employed to spray broadleaf weeds and woody vines in open turf, or in adjoining areas. Ester formulations of these compounds are especially harmful to young leaves and branches of trees. Avoid spraying when wind is blowing. Select periods of the day with calm wind conditions. The lethal rate of 2,4-D ester to hardwoods in pine stands is 1½-2 lb/A in 5 gal oil-water emulsion (1 gal diesel oil and water to make 5 gal/A.) In most cases except where spraying is done near trees, the rates would be reduced below lethal levels before the spray drift contacted the side or bottom areas of trees. Symptoms show in the leaves and either temporary or permanent damage may occur in the trees. Amine formulations of the growth regulators are safer to use near trees than esters.

Most preemergence herbicides can be used under well established trees. Rates for control of weeds preemergence should be safe under trees. The exception might be the growth regulators applied under small trees, or established trees with excessive water on sandy sites. One lb/A of 2,4-D amine will control most broadleaves found in resistant turf. This rate of 2,4-D is approximately 10 mg/square foot of soil surface. The lethal level of 2,4-D amine injected into a susceptible tree 10 inches in diameter is approximately 5 grams. By comparison a tree under which 1 lb/A 2,4-D was sprayed would have to absorb all of the 2,4-D applied to 500 sq. ft. of turf to be killed. This, of course, is impossible because of the protection of the roots by the soil.

Many preemergence turf herbicides are resistant to excessive leaching in the soil. These herbicides usually are confined to the top 2 to 3 inches of soil, except in sandy sites. Many of these herbicides are employed in woody plant nurseries for weed control without damage to young seedlings. Present day preemergence and postemergence turf herbicides can be used under and around established trees provided certain precautions are followed.

MH-30-T[1] (Maleic Hydrazide) has been effective for inhibition of regrowth in certain trimmed trees, privet hedge, and certain turf grasses. MH-30-T is safe to use around landscape plants.

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[1] A product of United States Rubber, Naugatuck, Connecticut.

SURFACTANTS

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Surfactants have many uses and are found in many forms (chemical composition). In order to understand what we are discussing let me give you a simple definition of a surfactant. A surfactant is a surface active agent -- this means that the compound will react with or at the surface of the material it comes in contact with.

Surfactants are divided into two classes: 1. Ionic, which is further divided into two subclasses a). anionic in which the linear hydrophobic (means close attraction or affinity for water) portion of the molecule forms the anion (negatively charged) in aqueous solution and b). cationic in which the linear hydrophobic portion of the molecule forms the cation (positively charged) in aqueous solution; 2. the second class of surfactants are nonionic. These materials do not ionize (split in solution and form positively or negatively charged ions) are hydrophilic (little attraction or affinity for water) in nature and end-groups are usually polar active.

The results from three research projects will be discussed. The work of J.H. Madison (University of California, Davis) will be discussed first.

Madison found that surfactants increased water infiltration into hydrophobic sands and reduced evaporation from sands. This study concerned the effects of nonionic polyethylene glycol on water movement in clay loam and silt loam soils. In laboratory and field studies, surfactants produced no significant difference in water infiltration rates. Conductivity or horizontal capillory movement under zero head was not significantly affected. Polyethylene glycol solution passed thru a sand column emerged as a diffuse band. Passed thru a clay column it was not recovered even with extensive leaching as measured by surface tension of the elute. Surfactant effect on air space vs. water was examined. In 0.50-1.0 mm sand with 40%/vol. porosity addition of surfactant caused the sand to lose 10 vol% water. No effect occurred on loam soils. Data indicate surfactant adsorbed by loam soils.

Law, Bloodworth, and Runkles (Texas A&M University, Department of Soil and Crop Sciences) found that nonionic surfactants lower the surface tension of water at very low concentrations. This property has been employed to increase water infiltration into soils with hydrophobic properties. Once in the soil, the nonionics are adsorbed and held by polar bonding forces to clay and other oxygen-rich mineral surfaces. Aggregate stability was improved by the nonionic compounds at higher concentrations but was not affected significantly at the lower concentrations. Their presence improved capillary flow characteristics proportional to the amount added to the soil, and crust

strengths were significantly reduced as measured by modulus of rupture. The 1% treatments reduced modulus of rupture values for both soils by a factor of 10. Lower treatment rates reduced crust strengths by lesser degrees. Consequently, all effects produced by nonionics were of a beneficial nature from the standpoint of agriculture soils.

Mistry and Bloodworth (Texas A&M University, Department of Soil and Crop Sciences) found that nonionic compounds increased the amount and the rate of infiltration in the initial stage, that is, in the first few minutes after the water was applied. They also found that nonionic compounds reduced evaporation at the higher concentrations following three irrigations.

Surfactants will not cure the problems such as compaction and poor drainage. They will not substitute for a good irrigation program. They might be used to carry a spot on a green or tee for a short period of time until it can be re-worked to alleviate the problem. More work needs to be done on surfactants before they can be recommended for general use.

IRRIGATION SYSTEM DESIGN

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Jim Eagles Sales Company
Fort Worth, Texas

Never before in the history of golf has the golf course superintendent played such an important role for his club and its management as in the consideration of implementing major improvements to his course. Rising costs, difficult labor situations, and unqualified personnel play an extremely important role in the decisions to be made. Existing courses must be renovated and re-developed commersuate with the newly constructed courses in order to sustain their individuality and the club members interests. Each of you, as Superintendents, know this is an imperative part of your position as the golf course manager. In deliberating the needs of your established course for re-development whether it be for an irrigation system, a new green, a new tee, a lake, a new pump station, or for whatever purposes, "design" should be given your prime consideration. Design is simply a plan to execute what you intend to accomplish. A good plan can assist you to evaluate the costs in presenting the project to your greens committee or to your club members. It can provide you with accurate cost data and insure that the project be accomplished in the most economical manner. Of course a plan retained will be of valuable assistance to you in the future after the installation of a given project.

Irrigation design necessitates that engineering features of the equipment to be used must be analyzed and used according to the manufactures recommendations. As discussed here today there have been some obvious failures in the automation of golf course irrigation systems in Texas, which should be a guiding light to the future golf course application of automation.

Each course demands that it be given individual attention and the requirements of the golf course superintendent must be included in the design factor. This is often overlooked and has caused numerous difficulties after installation because of misunderstanding and thought that the system installed was to solve all the problems of the course superintendent. It is suggested those familiar with turfgrass development, which is the prime business as a golf course superintendent, can assist with the implementation of necessary items in a course design. However, it is practical that velocities of water as it travels through pipe be considered by a competent engineer where high pressures and high volumes are used. Good design should include installation techniques and also the consideration of the maintenance for economical continued use of an automatic system. Of course, the basic ingredient for an automatic irrigation system is water and so often source and its depletion are overlooked entirely to the dismay of the owners after installation. Drainage is a factor that is very rarely given consideration on a flat plan but must be considered the over all aspects of any irrigation system, if one is to sustain traffic on his course after watering periods. Place design at the upermost part of your next project to insure that you and your club members obtain the best value for the money you intend to spend. Automatic irrigation is definitely a part of your future as a golf course superintendent for many obvious reasons. An objective look at the

future will tell you that you soon, possibly, you will have or will need a more detailed look into your irrigation requirements for your turf. After all, gentlemen, Turf is Our Business and it is our job to make it better for those who enjoy it and use it. Let's give them the best turf possible at the best possible price with all factors included. For the most part I'm simply stating that it is very easy to be sold a bill of goods by a salesman who can paint a beautiful picture. It is your duty to insist if a system is being considered for your course to interject yourself into the discussions and negotiations for the protection of those who trust you for the investment they have in their golf course. A design is as good as you will make it and it is imperative that you make it good for your future.

RECORD KEEPING AND BUDGETS

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People tend to judge a golf course by the portion with which they come in contact. That contact may be a drive by the golf course, discussion with the golf course superintendent or playing the course. If an individual has only one of these contacts and it is favorable, he tends to believe in the golf course program and its personnel. If this contact by the individual is unfavorable, he tends to criticize the entire golf course operation. Today, very few people, club members and even regular players take the opportunity and time to come in contact with the golf course's entire operations, consequently, their conception of the golf course in our busy, changing society is quite limited and often times biased. Therefore, a well planned, comprehensive, and eye-catching written report compiled from written records can do much to acquaint the players with the true image of a golf course.

Record keeping is a responsibility we should give more consideration to. Furthermore, this should not be done twice a month or even once a week, but a daily responsibility. Daily record keeping on proper forms which are adaptable for our own conditions will be of real value, both dollar wise and to the golf course superintendent as a professional. Lets get away from such expressions as "Record keeping is for my Chairman", or "This is something they should do in the Headquarters office".

We should give some thought to the basic purposes of written records. A recent publication stated, written records and reports are intended to either inform or persuade or both. Lets determine who is going to read these records and what we hope to achieve. They might be listed as follows:

1. First, we want to inform ourselves
2. We might also inform periodically, quarterly, semi-annually or annually our own employees.
3. Inform the Chairman of the Greens Committee or our immediate Superior. To do this determine -
   a) How and what records do we actually want to keep.
   b) Uniform terminology. I refer you to the golf course dictionary developed by the USGA.

We need not think we should develop such technical information as accounts payable, encumbrances, emotional studies, etc. On the job reports should be brief, concise and easy to keep daily records, which can be converted into a monthly and then an annual report.

The four major items to be included in record keeping and future budget preparation involves the following:

1. Labor
2. Material and supplies
3. Equipment
4. Future major improvements
5. Personnel

LABOR

As Dr. Marvin Ferguson emphasized in his presentation to the Texas Turfgrass Association in 1959 and I refer you to 1959 proceedings, provide a common denominator, it is suggested that in the case of labor "Manhours" be used to determine the amount of work on any part of the course. This can be related to dollars according to the hourly rate prevailing on any course.

He further suggested that "one acre" unit be used for measuring the amount of labor for maintaining fairways and roughs. This multiple provides a convenient unit by which to measure the amount of labor and the cost of maintenance. This multiple can then be related to the total area of the fairway or the roughs.

As a unit of measurement for maintaining putting greens, collars, and aprons, it is suggested that "1000 sq. ft." be used. This again can be related to manhours required per unit of maintenance. Dr. Ferguson explained the following formula to illustrate the method whereby we could determine unit cost would be as follows:

$$\frac{\text{Total Hours}}{\text{Number of Units X Number of Times mowed}} = \text{Hours per unit}$$

Suggested forms or records on labor may include the following:

Form 1 - A daily time sheet for the individual workman. Each workman should check the item on which he has worked during the day and record the hours in appropriate column. I might emphasize the daily time sheet should have a column noted as "other" and an explanatory note mentioning what was done.

Form 2 - A summary sheet for the transfer of the information given on daily time record. The superintendent should use this summary sheet to make a daily record of the total hours spent on each phase of the maintenance.

Form 3 - A basic data sheet which will serve as a description of the course with respect to the areas subject to various categories of maintenance. A print of the course may be used, however, there are available aerial photos made to scale which may be used.

Labor is one of the major items of expense in golf course maintenance and gradually rising.

After following the foregoing record keeping procedure on labor, I can report total hours of labor on certain areas of golf course maintenance which we have experienced in our particular situation. For example.

OPERATIONS-LABOR AN 18 HOLE COURSE	TOTAL HOURS FISCAL YEAR OCT. 1, 1964 - OCT. 1, 1965	TOTAL HOURS OCT. 1, 1965 - OCT. 1, 1966
Mowing greens	1,644 hours	1,560 hours
Changing cups	695 hours	690 hours
Mowing fairways	992 hours	926 hours
Ball washers - towels	131 hours	115 hours
Woodland - brush control	136 hours	236 hours
Service building - cleaning	1,536 hours	1,454 hours

Reveals:

1. Labor cost to change cups approximately $1,000.00 per year.
2. Total labor cost to mow fairways not much more expensive than to change cups.
3. Brush control 100 hours more than preceeding year. Why?

MATERIAL AND SUPPLIES

Due to the extensive use of chemicals in golf course maintenance today, there is a need for record keeping of chemicals used, for what purpose, time of year and accurate measurements, etc. We can not work with chemicals from memory alone.

I have experienced one additional major advantage in record keeping on materials and supplies and that is, in our own organization, we were making too many "emergency purchases" and with some kind of advanced planning with written records we would have saved money by making purchases in larger quanities and in a more orderly manner.

The USGA Journal in August 1962 emphasized that use of some standard of measurement as in the case of labor. For solids, such as powdered or crystalline materials, use ounces and pounds. For liquids, use liquid ounces, pints, quarts and gallons. These standards of measurements enable us to use measurements and quanities as stated by the manufacture. It is hazardous to use soft drink bottles, beer cans, etc., as a chance for error is permitted that is not necessary. Normally the container will specify, in the case of chemicals, the amount of pounds per gallon per measurement (sq. ft. or acreage).

Fertilizer rates also require some calculation. A suggested formula may be as follows:

Desired rate of nutrient times 100 divided by percent concentration equal rate of application. The formula may be written:

$$\frac{RX100}{\%\ \text{nutrient}} = \text{Rate of application}$$

Assume that 60 pounds of nitrogen per acre is to be applied using a 12-12-12 fertilizer, then substitute figures in the formula as follows:

Desired rate (60 pounds) X100 divided by percent N (12) equal rate of application or

$$\frac{5X100}{1} = 500 \text{ lbs. of } 12\text{-}12\text{-}12 \text{ per acre.}$$

Form 4 - A summary sheet showing supplies purchased. This information should be drawn from invoices or purchase orders.

EQUIPMENT

I will not attempt to recommend any established form of record keeping for equipment, however, record keeping on this particular item should include gasoline equipment records, mileage or hours used. As in the case of labor and materials-supplies, a standard of measurement is essential. Furthermore, additional information is needed including the following:

1. Cost of equipment when purchased
2. Inventory number
3. Maintenance and repairs
4. Standard of measurement when used - mileage or hours
5. Replacement schedule

For example, record keeping on a vertical mowing machine on the greens totaled 170 hours use during the fiscal year October 1, 1964 - October 1, 1965 compared with 126 hours during the fiscal year October 1, 1965 - October 1, 1966. You can realize the importance of these figures when we point out the machine was used - eight years or totaled 1500 hours use during its lifetime and the purchase price was $500.00.

For example, vertical mowing machine for its 8-year lifetime use:

Cost

Purchase price----------	$ 500.00
Parts to repair----------	500.00
Labor to repair----------	800.00
Gas and oil----------	100.00
	$1,900.00

. 1500 hours for the 8 yrs. = $1.27 per hour excluding labor to operate.

If you provide these figures to your immediate superior, either verbally or in written form, he is going to be convinced a detailed record has been kept and you will get a more favorable response.

Form 5 - A summary sheet of equipment and maintenance cost.
Form 6 - An inventory of equipment.
Form 7 - Equipment operation record. This should show the item of equipment, and identifying number, and a record of its operation.

PLANNING AND MAJOR IMPROVEMENTS

I think it is always adviseable to always have a plan for major improvements on the golf course. In other words, some thoughts toward major expenditures or improvements not covered in the annual day to day operating budget. Admittedly, you may have to keep this in your file for 4 or 5 years, which in itself is one kind of record keeping. A word of caution here. Do not ever make a recommendation for a major expenditure without having done the following:

1. Emphasize service to golfers.
2. If possible, personally inspect this improvement at another golf course.
3. Discuss informally with your immediate superior at some opportune time, then follow up with your written recommendation.
4. Include all related costs - construction, design.
5. Don't let a negative vote on a recommendation destroy your incentive. Emphasize our golf course not my course, my labormen or my equipment.

PERSONNEL

This is not to be confused with labor and hours, but strictly employee records - character reference, salary, job performance, safety record, employment date, etc. There are many types of forms for this record. Some golf course superintendents keep individual file on each employee.

ADVANTAGES IN RECORD KEEPING AND BUDGETS

In conclusion, I want to mention briefly some thoughts in record keeping and budgets.

1. If we want to advance in our profession, we must maintain a more complete and accurate analysis of costs to operate a golf course.
2. Record keeping will result in a more careful measurement and a more careful application in use of materials.
3. We will become better acquainted with the golf course in actual size of certain areas.
4. Record keeping provides better means for us to communicate to our superiors.
5. Provide an accurate record for a comparison on a year to year basis.

6. It is not good to compare costs between clubs except on the basis of units of maintenance.
7. Specific forms and systems of record keeping will depend upon the individual and the club.
8. Written records will result in golf course operations being based on facts instead of opinion.

ECONOMIC CONDITIONS OF MODERN IRRIGATION DESIGNS

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Let's daydream a bit into the year 1980. Dallas and North Central Texas are experiencing one of the worst droughts in ten years. However, surprisingly the high plains of West Texas are being flooded with torrential downpours, and golf course operators are working around the clock to prevent high water damage to the well manicured greens and tees. In the Southeastern part of the State things are about normal with San Antonio and Corpus Christi experiencing only slight drought conditions.

Back in Irrigation Control at College Station, Dr. Marvin Ferguson receives these reports from the respective regions and immediately feeds the information into his #0001 computer which in turn will signal Turf Irrigation Satellite X. All automatic irrigation equipment, including home lawn sprinkler systems, will be programmed by specific area to compensate for an accelerated or decelerated automatic watering schedule.

Sounds fantastic, doesn't it? However, when you realize that our turf irrigation industry is just about as old as aviation, it really shouldn't be too farfetched. Admittedly our industry has not made the strides and refinements that we now see in aviation from the flying jenny to the soon to be activated supersonic transport. You might say we in the irrigation industry are still in the DC3 era and we've got a long way to go. In this vein we perhaps need to be more consumer-oriented and more fully aware of your problems rather than just producing equipment to distribute water.

Are the people ahead of the products, or are the products ahead of the people? Certainly there is need for improvement in both areas. And it is evermore important that we acquaint ourselves with the economics of modern irrigation that are so necessary if turf management and irrigation are to parallel the advancements of aviation and other surrounding industries. As modern turf managers, it is your responsibility to know and understand the economic conditions surrounding your irrigation project and make your decisions accordingly.

Only recently our industry has moved forward in developing up-to-date economic studies. In addition to work our company put together on data collected from the Twelfth Naval District[1] several years ago, we now have outstanding information provided by the April issue of Grounds Maintenance magazine[2] and by the comprehensive report from the Economics Research Laboratories, California[3]. Essentially all recent economic studies on modern irrigation design relate to the three essential variables. They are as follows.

1. Original installation cost.
2. Water cost.
   a. Fuel cost for pump system.
   b. Metered water cost for city water supply.
3. Labor.

Obviously, water and labor costs are two essential variables which are uncontrollable by you as they are swept along in the inflationatory cycle of the times. I don't have to tell you superintendents what has happened to wages in the past two or three years, and if we follow the guidelines established by the Federal Government in respect to minimum wage laws, we are experiencing fantastic escalation in this one area alone. If you assign a 10 percent annual increase to accumulated water and labor costs this will result in more than a 50 percent increase in operating costs within five years!

Therefore, it is evermore essential that we carefully weigh number one, the original cost of the system. What can we afford? What can we not afford? "The sweetness of low price is often offset by the bitterness of poor quality and/or false economy at D Day and/or time of decision."

Beware of the low bidder. Remember that he is bidding on specifications of his own making. It was Ruskin who said, "There is hardly anything in the world that some men cannot make a little worse and sell a little cheaper; and the people who consider price only, are such men's lawful prey."

It is disappointing to note the number of fully automatic golf course systems in this State alone that have been converted back to manual, resulting in higher labor costs, to say nothing of less effective watering with no improvement towards the irrigation job to be accomplished.

Let's remember, gentlemen, that one of the main purposes of modern automated irrigation is not only to relieve excessive operating costs but to provide a better way to water! Sometimes we lose sight of this in our analysis of automatic systems. When we are considering major investments approaching $100,000 the additional cost is surprisingly small to go to two rows versus one, which will give you 50-65 percent better control of your water for a possible 15 to 20 percent increase in original cost.

Why do we have these problems? Now, I realize that many of my learned colleagues attending this Conference have presented numerous solutions. Every day in this industry we find people running around with solutions who really don't understand the problem! Perhaps the best way to analyze our problems is to go straight to the cause:

1. Inadequate information.
2. Incompetent design.
3. Inadequate and hurried research on the part of management making the decision.
4. Poor product.
5. Poor installation.

Solutions to the problem as we see it would be:

1. Better education in the turf schools for superintendents. You are called upon to advise management and make recommendations on a very major capital improvement but there has been little, if any, exposure in your training towards:

   a. Basic hydraulics.
   b. Design of sprinkler system.
   c. Fundamental mechanics of installation and service.

2. Hire a professional - an independent consulting engineer, preferably a civil engineer. He need not be an expert in irrigation but a graduate engineer does understand basic hydraulics, topography, mechanical design and pump capacities. He can assist you tremendously with a learned opinion. Hire this man either in the design stages or a consulting capacity, after you have several plans to review. It is entirely possible with professional advice you can find it an advantage economically to negotiate with a compentent source for the entire project.

3. Last of all, be objective and not subjective. Regardless of whether a man making your irrigation presentation is an expert in plant agronomy, pathology, and knows his herbicides and fungicides backwards and forwards, this does not necessarily qualify him as an irrigation expert. Many of your major turf houses today treat irrigation as an afterthought or a sideline. Look for a specialist in the field and insist on reviewing the individual's background and experience.

   So-called experts have been guilty of recommending square spacing instead of triangular, a cardinal sin, wherever we have wind conditions to consider and are really concerned with uniform coverage. Another good trick is to haphazardly add additional heads to the system during installation to improve coverage in areas that were not previously planned correctly. This often results in flooding the approaches to greens and low spots in the fairway, resulting in continued damage to the turf, mud holes and generally sloppy conditions.

   Beware of the guy who designs from a flat piece of paper. The importance of accurately evaluating the topography of your course is absolutely essential for the two main purposes:

   a. Obviate drainage problems.
   b. Control excessive pressures.

      Remember that 100 Ft. of elevation is equal to 43 Lbs. per square inch. Unfortunately, we have seen the disaster of systems designed without taking elevation into consideration. High surge pressures result in accelerated wear to your equipment as well as being extremely harmful to the piping system. The result is frequent repairs and high maintenance cost.

   Know your contractor. Be sure his is qualified. The golf course field, gentlemen, relates itself more closely to a utility contract than anything else. Out company has over three-hundred well qualified sprinkler installers, and of the entire group we would probably recommend only three or four for a golf course job. A golf course contractor must have:

   a. Competent personnel.
   b. Adequate capital.
   c. Engineering supervision.
   d. Heavy equipment.
   e. Know-how and/or experience.

   Always insist on references and examine his facilities carefully; visit some of his existing jobs.

4. Certainly there is a big gap in the flow of communication from the superintendent to the manufactures of equipment. I recommend to you various turf grass associations throughout the country that you appoint a knowledgeable panel of operators to carefully evaluate your needs and objectively weigh your needs. Present this information to your manufacturers. We'll listen. It's the only way we can provide better equipment and service for you.

5. Know your product. Don't experiment with a $100,000 installation. Buy only from reputable manufacturers in the field. Wherever possible purchase the entire package. This eliminates divided responsibility and isolates problems to one source. Don't be penny conscious and pound foolish and mix such generic equipment as valves and controllers. Insist on valves and controllers of the same manufacturer. This is necessitated by the recent influx of underground valve manufacturers and the wide range of tolerances in coils or solenoids that may or may not be companion to the controller in electrical characteristics. I reference primarily electric systems. However, this is obviously the trend throughout the nation. There is a difference, gentlemen, in the capacities and limitations of individual products, and unless you are qualified and have complete testing facilities you're inviting trouble with product mix.

In summary, I don't want you to feel that we have taken a negative approach to the subject. On the contrary, there are more and more successful automatic installations being installed every day throughout the country. We are really just getting started. We are all going to benefit from the problems of the past. There are certainly better products available today than ever before, and bigger and better improvements are on the way.

In closing, I assure you that you won't be disappointed if you follow the basic recommendations that we have outlined. And to borrow our "outfit's" slogan you will really find, "It's a wonderful way to water."

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1 Sprinkler Irrigation Cost Analysis, Weather-matic Sprinkler Division, Telsco Industries, P.O. Box 18205, Dallas, Texas 75218.

2 "How to Select a Sprinkler Irrigation System," Grounds Maintenance magazine, April, 1966.

3 Economics Research Laboratories of California.

PROBLEMS IN OPERATION

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Problems in an Automatic System

I Bad Design

II Badly Planned Programming

III Improper Selection of Equipment to Fit the Situation

IV Inadequate Pump Station

V Improper Installation

I Bad Design

Dead end systems take a great deal of punishment due to their basic design of not being looped.

Unbalanced systems unload more water in higher pressure areas than in lower pressure areas. Coupled with a program problems, this gets very serious.

High velocity, coupled with the foregoing, presents a problem that can result in a systems' actually tearing itself apart over a period of time, rupturing pipe, tearing out fittings. This is caused usually undersizing pipe in an effort to sell merchandise. The pipe manufactures specify that velocities should not exceed 5 feet per second. One manufacturer backs their pipe at 8 feet per second on rubber joint PVC, but still recommend 5 feet per second on A C pipe.

II Badly Planned Programming

An automatic sprinkler system is not one system but many. After all design work is done, the programming takes place and should always be done by the same man who designed the system. Programming is done with controllers.

No one set of heads, 1, 2, or 3 should have to run with any other heads on another part of the golf course and be tubed or wired to the same controller. In other words, each set of 1, 2 or 3 should have its own station, on its own controller. Then each station has its own variable time to conform to its soil and terrain conditions

System should be arranged so that one side of 9 greens can be watered at one time and 9 tees can be watered at one time. All could be watered a different length of time.

The greens and tees should never be run at the same time as the fairway controllers on a regular cycle. One should preceed or succeed the other, which ever is the preference of the superintendent and according to the area.

There are automatic systems in the state of Texas that have greens and tees on the same tube or wire, and station on the controller.

III Improper Selection of Equipment

Clean Water Conditions

1. Almost any major line of head, impact, cam or gear will operate under clean water conditions. The only disadvantage would be an uneven rotation with sprinklers without positive drive.

2. Electric or hydraulic valves work equally as effective under clean water conditions, providing of course, that proper wire size, insulation and tube selection is made. On larger systems, the valve under head hydraulic seems to be more trouble free.

Dirty Water Conditions

1. Any solenoid valve should not be operated under dirty water conditions. No impact, rotary or cam drive rotary should be used with dirty water. The sediment or particles in the water pass through the drive mechanisms and wear the head severly. In the solenoid remote valve, the dirty water will stop the valve from opening, and the valve must then be dug up and cleaned. In the specification, it should call for a large backflush filter whenever solenoid valves are used and/or whenever gear heads with exposed gears, or cam drive heads are used.

Pipe

Proper selection of pipe should be made on the basis of operating pressure, soil conditions, and type of use.

IV In-adequate Pump Station

Most pump stations that give trouble are guilty of bad design, bad application, improper installation or cheap pumps.

Many times the pump station has been designed so closely that it could never work perfectly.

The jockey pump is usually inadequate or absent altogether.

The pressure tank may be too small to prevent water logging.

The method of injecting air is inadequate. Air compressors are generally at fault here. There are new air injectors on the market build with golf courses in mind. Nu-Matic is one of these.

Check valves and gate valves are frequently placed in the wrong location.

Flumes are many times placed too low or at the wrong angle and silt up. Some are placed too high and create a vortex.

Many times, pumps are installed with a rigid connection.

Pressure relief and by-pass valves frequently are placed in the wrong position.

Turbin pumps for use on a golf course should always be water-lubricated to avoid oil drippings on the greens.

V Improper Installation

Causes

Bad Management

Inexperienced personnel

Bad Design

Wrong Wire Size

Carelessness

Bad Selection of Materials

Controllers

Electric

Advantages

1. No freeze problem
2. No filter problems for controllers

Disadvantage

1. None on equal equipment

Hydraulic

Advantage

1. None on equal equipment

Disadvantage

1. Must be filtered on dirty water
2. Must be equipped w/TH, insulated, inside heated building, or operated with anti-freeze.

Hydraulic Valves

Disadvantage

1. Longer to install
2. Requires bleeding of tube system when placing into operation lst time.

Advantage

1. Can be buried without access
2. Require no cleaning and very low maintenance.
3. One moving part
4. No internal bleed
5. No solenoid

6. Slow closing
7. Sequence closing

Electric Valves

Disadvantages

1. Must be cleaned or serviced under dirty water conditions
2. Buried solenoids are not guaranteed by major manufactures
3. Moving parts
4. Internal bleeds
5. Installation of wire is too expensive
6. Fast closing
7. Total closing

Advantages

1. Easy to install
2. Easy to start into operation

Tube

Advantages

1. Stronger joints
2. Heavier, tougher cover .050
3. 1700 PSI test on PVC tube
4. Easier to find leaks after installation
5. Can lay in same trenches without problems

Disadvantages

1. Longer to install
2. Harder to put into operation upon installation

Wire

Advantages

1. Easier to install
2. Easier to put into operation

Disadvantages

1. Corrosion
2. Electrolysis
3. Creep
4. Harder to find problems

WHAT'S NEW IN FERTILIZERS

Dr. Yates Smith
Tennessee Valley Authority
College Station, Texas

More new developments in fertilizer technology have occurred during the past few years than in any similar period in the 125-year history of the industry, and many new ones are in the making. If fact, changes are coming so fast that we can scarcely keep up with them, let alone get them into any sort of perspective.

It is my assignment today to tell you what all of these developments mean. But I must warn you at the outset that my comments will be superficial. I don't think any of us have a crystal ball that will do the assignment justice.

There are a couple of things, I think, of which we can rest assured. First, the more important technological advances made in the past few years will continue to spread through the world fertilizer industry. Second, major new advances in the making will exert profound influence in the future upon the kinds of fertilizer used, and upon the ways in which they are produced and marketed.

There are several good reasons behind these two assumptions.

- We are entering a vast new era in fertilizer production and use, triggered by the War on Hunger. Fertilizer is a major and essential input in this War. It makes possible dramatic improvements in food production--and amazingly, for the first time everyone knows it. Indications are that world fertilizer production capacity by 1970 will nearly double the 1965 level in order to meet estimated needs. During a period of such rapid expansion, new technology is at a premium since no one, even in the most underdeveloped countries, wants fertilized plants that produce obsolete products or that use inefficient processes. Within our own country, the production lid is off as a result of dwindling stockpiles and the pressing food grain needs of developing countries. With our own expanding population, there is an ever increasing need for additional parks and recreational areas.

- Our highly competitive and technologically-minded industry, now supported for the most part with strong capital backing, will continue to be receptive to the addition of new technological advances.

- The shortage of sulfur, should it persist, probably will spur a scramble for phosphate processes and products which require less of this vital material.

Probably the main stumbling block to continuing technological progress, particularly in the creation of new products and processes, is our difficulty in recruiting into the fertilizer field highly competent and qualified young scientists, engineers, and economists. Too long has the image of agriculture and anything to do with agriculture been abused in

the public eye. Perhaps now, with the awakening of the world importance of fertilizers, there will be a reversal. Universities certainly should devote more effort to interesting students in the field of horticulture, park management and fertilizer technology.

Now, let's look at some of the major recent advances as a result of fertilizer technology, along with some that may occur in the fairly near future, and try and get some order and meaning into them.

More Concentrated Fertilizers

One of the most important advances in the field of fertilizers, both in the United States and worldwide, has been higher analysis fertilizers. Higher analysis materials and mixtures everywhere have been on the increase.

This trend will probably accelerate. First, a major portion of the cost of fertilizers to consumers, about 40 percent, is associated with the cost of shipping, handling, storage, and bagging. Strenuous competition for markets assures that various members of industry will take advantage of any savings possible in high-analysis materials. Second, as developing countries become more sophisticated in fertilizer use they will demand high-analysis fertilizers in order to counter their poor transport and storage systems, lack of port facilities, and need for ocean shipment. Third, we have the necessary high-analysis products already well established which will permit average nutrient contents to approach 50 percent (in fact, the average nutrient content of fertilizers consumed in a number of states now exceeds 40 percent). A number of new high-analysis products already appearing on the market or under development in research laboratories and pilot plants will further spur the concentration trend.

I would like to discuss just briefly the state of the art of developing new high-analysis materials. Long ago we passed the stage of eliminating inert materials or fillers, and we have gotten well along in eliminating by product compounds from the fertilizers, such as gypsum. The challenge now is to select compounds high in the plant nutrients and low in oxygen. Many of these compounds in themselves are not useable directly by plants but must undergo chemical and biological transformations in the soil before their nutrients are available.

Superphosphoric acid and the resulting polyphosphate-containing fertilizers is a good example. Here, though molecular dehydration of orthophosphates, we produce higher polymers such as P_2O_7 (pyrophosphate), P_3O_{10} (tripolyphosphate), and P_4O_{13} (tetrapolyphosphate), each containing progressively higher proportions of phosphorus and lower proportions of oxygen. However, these compounds apparently are not taken up by the plant as readily as orthophosphates; rather they undergo hydrolysis in the soil before they are used.

Polyphosphates so far have had a major impact in the clear liquid mix industry in increasing the nutrient content and in sequestering impurities and micronutrients. However, solid ammonium polyphosphate (15-60-0) is now being produced on a demonstration scale by TVA. This material can either be dissolved and utilized

to produce 10-34-0 liquid blends or grades that are normally produced from a 10-34-0 liquid base. It also can be incorporated in solid form in dry mixes to produce grades such as 13-26-26, 10-20-30, 20-20-20, and 40-13-0. Although solid ammonium polyphosphate is now being produced from furnace-grade superphosphoric acid, there are processes under development for producing it directly from wet-process acid.

I feel that we can expect ammonium polyphosphate to become increasingly important, first in the United States, and then worldwide.

Possibilities exist for producing other polyphosphates. Calcium polyphosphate (56% P_2O_5) can be produced by calcination of triple superphosphate, and potassium polyphosphate (such as 0-57-37) can be made by heating a mixture of phosphoric acid and potassium chloride. The production economics of the latter, however, do not appear too favorable.

There are, of course, chemical compounds of even higher nutrient concentrations that are possible with the polyphosphates. Extremely high-analysis grades such as 44-75-0 and 36-91-0 can be made by reacting ammonia, phosphorus, and oxygen under high temperatures and pressures. A number of these compounds are known but so far they have received little consideration as fertilizer materials. TVA is currently doing some research in this area. While these products represent the ultimate in nutrient concentration, many obstacles block their development and use. Not all become available for plant uptake after addition to the soil, and there are no processes developed for large-scale commercial production. Production costs may prove prohibitive.

Not all advances toward high-analysis materials, however, come from development of dramatic new compounds. Process improvements or combinations of compounds that lower the cost of manufacturing or permit improvements in quality often are of equal importance. An example of this is urea - ammonium phosphate that combines urea and diammonium phosphate into one homogeneous product. A variety of high-analysis grades can be made, such as 35-18-0, 25-35-0, 29-29-0, 38-13-0, 25-15-15, and 16-22-22. So far these grades could be produced only by direct physical blending. However, with new technology it is possible to produce them by using urea in solution form direct from a urea plant and reacting it and additional ammonia with phosphoric acid. Urea solution is relatively cheap; the expensive urea prilling step is avoided and a single granulation step is substituted for separate prilling of urea and granulation of diammonium phosphate. As a modification, triple superphosphate may be substituted for phosphoric acid to produce slightly lower analysis grades. Urea - ammonium phosphate may become an important fertilizer material because of its high analysis, economies of production and transportation and the possibility for producing a wide range of agronomically suitable grades without problems of segregation.

In the case of straight nitrogen materials, anhydrous ammonia has already permitted us to achieve the ultimate in nutrient concentration. Urea, as our highest analysis solid nitrogen carrier, can be expected to replace ammonium nitrate and other lower analysis products since

distribution and handling costs play such a vital part in the total cost to the consumer. Further, urea holds definite advantages over its nearest competitor, ammonium nitrate, in the cost of production. Also, investment and operating costs appear to be lower for urea since the separate nitric acid step is omitted.

Growing Importance of Secondary and Micronutrients

The increasing importance of secondary and micronutrients in turf production has focused considerable attention upon their use and application and encouraged new research and development activities in the field of fertilizer technology. Research has so lagged over the years that much new knowledge must be gained before we can expect either highly effective and efficient fertilizers containing these elements or their wise application and use.

The ideal way to apply most secondary and micronutrients is, of course, to incorporate them into fertilizers along with the micronutrients. This, however, brings up a number of problems. Chemical reactions often bring about undesirable solubility changes; segregation occurs in granulated fertilizers; and there is always the problem of getting the right nutrients in the right amounts and combinations to meet specific soil and turf needs.

Progress is being made, however. Polyphosphates, as a result of their sequestering action, have opened up the liquid mixes as a carrier of micronutrients. Suspensions have been found to be good carriers. Use of adhesives to uniformly coat granular fertilizers with micronutrients shows real promise. Successful introduction of elemental sulfur into the manufacture of concentrated superphosphates and into anhydrous ammonia, the incorporation of zinc into solid polyphosphates, and the use of metal ammonium phosphates and certain chelates all are encouraging advances. But a great deal more must be accomplished.

Already a number of soil areas in various parts of the country require additions of not only the major nutrients, but of a secondary nutrient and two or three micronutrients. Determining the desired nutrient rates and balances presents a tremendous challenge to agronomists and horticulturists and an even greater challenge to the industry in compounding fertilizers that will meet these requirements. In my opinion, this is one of the most important problems facing the land-grant colleges, TVA, and the industry in the years immediately ahead.

Building Agronomically Better Fertilizers

We are always hoping to develop new fertilizer materials that will give more response per pound of nutrient than conventional materials. Offhand, the door would seem to be wide open. Agronomists lament the fact that turf and ornamental crops recover only 50 to 75 percent of the nitrogen applied, that seldom do they recover more than 30 percent of the phosphorus in the year applied, and that crops frequently take up potassium in luxury quantities.

But the facts remain that in 125 years we have not come up with a phosphate that is universally superior to superphosphate, although polyphosphates seem to offer some hope; that the old axiom " a pound of nitrogen is a pound of nitrogen regardless of source" still holds, providing that each material is applied in a manner and under situations favorable to its use; and that no one has come up with a potash better than that we get from the mine.

Slow-release nitrogen compounds--and there are a number of them, are already in commercial production. Further, there are no valid field experiments, to my knowledge, that have shown markedly improved nitrogen recoveries resulting from the use of slow-release compounds. But there is always hope. Coatings on the fertilizer granules with materials such as sulfur offer some promise. Nitrification inhibitors with block nitrate formation of ammonium-containing fertilizers also offer possibilities. Interest in these products, however, is likely to increase as a result of the buildup of nitrates in groundwaters in certain heavily fertilized western irrigated regions.

Laboratory studies of polyphosphates in soils generally indicate that they form insoluble compounds more slowly than do orthophosphates. Except in a few instances, studies have failed to show a consistent advantage of polyphosphates over orthophosphates.

Water solubility of the phosphate in mixed fertilizers still remains an important factor in determining their agronomic effectiveness under certain conditions. Water solubilities of 40 percent or more appear satisfactory for practically all conditions, and those below about 5 percent are often unsatisfactory. This is about the best guidelin that agronomists can agree upon, which isn't too satisfactory from the fertilizer technologist's viewpoint of building agronomically better fertilizers.

Products Aimed at Labor Saving

With the increasing and often acute shortage of labor and heavier per acre applications of fertilizers, turf specialist will continue to take advantage of any product or service that will reduce their labor requirements. Chief among these so far have been increased use of nitrogen solutions, and clear liquid mixes which require less labor to handle than solids; the use of more concentrated fertilizers, both solids and liquids; custom application; and the use of improved fertilizer distribution equipment.

Successful application of certian weed killers and insecticides into nitrogen solutions and liquid mixes seems to assure expansion of this practice. Liquid fertilizers are particularly suited as carriers because small amounts of pesticides can be applied uniformly.

Slurries or suspensions, with their higher nutrient concentrations than clear liquid mixes, appear to be gaining favor. However, crystal growth and settling during prolonged storage are still a problem and may be a key factor in determining their future.

Products Saving on Sulfur

The current and possibly continuing shortage of sulfur may influence the kinds of phosphate fertilizer produced and the processes for their manufacture. It has already stimulated new research.

Most soluble phosphate fertilizers utilize sulfuric acid in their manufacture. The amounts of sulfur require for different products vary. Diammonium phosphate, for example, requires 0.94 ton of S per ton of P_2O_5, triple superphosphate 0.67 ton, and ordinary superphosphate about 0.60 ton. If the sulfur shortage persists, a logical first step is probably a shift in new plants away from diammonium phosphate to lower analysis grades compounded with triple superphosphate.

Considerable interest, however, is developing in the replacement of sulfuric acid by nitric acid in fertilizer manufacture. Nitric phosphates already are produced extensively in Europe and there are a few plants in the United States. In most processes, however, sulfuric or phosphoric acid is used also to form sufficient ammonium phosphates to hold the water solubility at around 40 percent. Such processes require about 0.60 ton of S per ton of P_2O_5.

Of prime interest are the Odda-type nitric phosphate processes which require only nitric acid. The water solubility of the phosphate depends on the proportion of calcium nitrate removal, and products usually range from 30 to 50 percent water solubility. Calcium carbonate is the byproduct. However, the Odda-type processes are complex, and there is little flexibility in $N:P_2O_5$ ratios.

Research and development people believe that a straight nitric acid process can be developed which will overcome the disadvantages inherent in the Odda process. The sulfur shortage certainly will encourage effort in this area. Additional encouragement also is indicated in that nitric acid prices, as contrasted to sulfuric, are expected to fall because of recent breakthroughs in producting ammonia and because of technological improvements in the conversion of ammonia to nitric acid.

Phosphoric acid produced by burning and hydrating electric furnace phosphorus is another route requiring no sulfur. Presently only a small percentage of electric furnace phosphorus goes into fertilizers, and most of this into clear liquid mixes. However, if the price of sulfur increases sufficiently and the price of electricity decreases (as a result of the construction of large nuclear power plants), furnace phosphorus may be used more extensively for fertilizers. Shipping elemental phosphorus, of course, could result in some real economies.

CONTROL OF DISEASES

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Prerequisite for control of any disease is knowledge concerning the cause or causes of that disease. Most recommendations for control are based on visual analyses of the symptoms exhibited in the turf. Because specific pathogens produce certain typical symptoms, these recommendations are generally very good. The symptoms exhibited by any given pathogen are usually consistent enough to recognize from photographs. A very good example of this is the disease "large brown patch" caused by the Imperfect fungus, Rhizoctionia solani.

The time and space alloted here will be devoted to comments concerning types of pathogens and some of the research work necessary for arriving at suitable control recommendations.

In 1882 Robert Koch published what has since become known as "Koch's Postulates". While they were prepared to stimulate better experimental procedures on animals, they are applicable to plants as well as animal diseases. They should be met before pathogenicity is claimed. Briefly stated they are as follows:

1. The microorganism must be associated with the disease, and conversely, the disease must not occur without the microorganisum being present.

2. The microorganism must be isolated in pure culture and its specific characteristics studied.

3. When the host is inoculated with the microorganism under facorable conditions, the characteristic symptoms of the disease must develop.

4. The microorganism must be reisolated and identified as that first isolated.

Unfortunately, the postulates cannot be applied to all plant pathogens, because for certain ones, called "obligate parasites", the culture technique has not yet been developed.

The pathogens found in turf and brief comments about each can be listed as follows:

1. Bacteria- Usually these are not very important as causal organisms. However, various species are always present and are thus recovered during the isolation of the other organisms which are pathogens and which do incite plant disease.

2. Viruses- At this time none of the important turf diseases are attributed to viruses. Some viruses are known to be serious pathogens in other plants. One very good example is the

Tobacco Mosaic Virus of tobacco. Curly-top of tomato is also caused by a virus.

3. Nematodes- While nematodes are usually not listed as pathogens, they merit some consideration here in that serious infestations have been observed in turf. Pratylenchus spp. (commonly called "meadow namatode") has been known to cause an unthriftiness in turf. In such cases, pronounced results can be obtained from applications of a suitable nematacide. Helicotylenchus spp. (commonly called "spiral nematode") is also often found in turf samples.

4. Fungi- This group of organisms is by far the most important of the pathogens of turf (and other crops in general). Without delving into mycology very thoroughly, it will suffice to say here that there are two main groups of fungi. They are; a) Perfect, or those in which a sexual cycle occurs and b) Imperfect, or those in which there is no sexual cycle.

In many cases the perfect stage of one organism has one name, while it has a different name in the imperfect stage. This situation has come about because the conditions under which the two different stages usually develop are usually quite different. One case in point is that of Ophiobolus graminis. This is an Ascomycete (forms spores sexually in a structure called an ascus) while the imperfect stage is classified as a Helminthosporium. Ophiobolus Patch has been reported as a serious turf disease. The symptoms of this disease are strikingly similar to those of the malady of bermudagrass in Kansas, Oklahoma, and even some parts of North Texas which is called "Spring Dead Spot". However, the researchers thus far have consistently isolated Helminthosporium spp. from Spring Dead Spot areas but as yet Ophiobolus spp. have not been observed. This is not to say that Ophiobolus spp. is in fact the causal organisum but, this possibility should not be overlooked!

5. Physiological Diseases- This is a catch-all classification which is used to include those disorders often found which are not readily attributable to any presently known cause. As more and more research is conducted, the diseases classified in this group are removed because the actual cause and effect become established and what was at one time called "physiological" can then be accurately classified according to the true causal agent.

With a few slides, I want to show you the appearance of some of these organisms as they appear in a close-up view. The purpose of this presentation is to try to give you a better appreciation of some of the problems and facets associated with this "business of Control of Diseases".

CONTROL OF INSECTS

L. W. DuBose, Jr., Superintendent
Houston Country Club
Houston, Texas

The materials I use at the Houston Country Club are Sevin, Malathion, Heptachlor, Chlordane and Dieldrin.

All materials should be used with caution. Read the label and do not exceed the amount of material recommended.

I always add a spreader-sticker with insecticides even though it is not mentioned with each chemical. Four to six ozs. per 100 gal. of water is enough. One should check and see if the spreader-sticker is compatible with the material being used.

SEVIN 50W

Sevin 50 W.P. is one of the safest materials to use. For lawn areas, Sevin 50W at these rates, one cup or 8 ozs. in 20 gal. of water on 500 sq. ft. or 40 ozs. to 100 gal. of water with 4 to 6 ozs. spreader-sticker on 2,500 sq. ft., will control ants, chinch bugs, earwigs, army worms, flies, sod webworms, leafhopper, mosquitoes, ticks, fleas, and others.

I consider these rates heavy. There are a nember of insects that can be controlled with 32 ozs. of Sevin 50W in 100 gal. of water, using 50 to 100 gal. to the acre. On closely mowed areas, 50 gal. would be enough. On tall grass, it could go up to 100 gal. in order to wet the plants or grass.

CHLORDANE 40 W.P.

Chlordane will control - ants, army worms, chiggers, crickets, grasshoppers, spiders, sod webworms, mole crickets and ticks.

Use 1/3 to 1/2 lb. of 40 W.P. to sufficient water to spray 500 feet or 1 to 1 1/2 lbs. of actual per acre, 43,560 feet. For white grubs and wire worms use 3/4 to 1 1/2 lb. to treat 5,000 feet or 2.5 to 5 lbs. per acre. Do not use more than 2 lbs. actual per acre, and again use spreader-sticker.

MALATHION 5-E

We use malathion on ornamentals mostly.

For control of - red spider, white flies, aphid, bag worms and asps.

Malathion will control many more insects. One quart or 32 ozs.

per 100 gal. of water will kill most insects. I sometimes use it at the rate of 1 oz. per gal. of water with no ill effects to plants. Again use spreader-sticker.

HEPTACHLOR 5G or 10G

I use Heptachlor to control these insects - ants, chiggers, earwigs, grasshoppers, mole crickets, pillbugs, white grubs, wire worms, sod webworms, grasshoppers and ticks.

Heptachlor 5G used at 40 to 60 lbs. to the acre or 1/2 this amount of 10G.

I use 1 lb. of 10G per 1,000 feet on my greens two times a year to control sod webworms and other insects in the soil. In order to get good distribution I take 2-50-lb. bags of milorganite and one 50 lb. bag of Heptachlor 10G mix them together and apply this material on my greens at the rate of 3 lbs. per 1,000 feet, this gives me 1/10 lb. actual of Heptachlor per thousand feet.

Heptachlor has a long residual but through top dressing we move the material down where sod webworms do not come in contact with it.

DIELDRIN

Dieldrin is also effective for sod webworms and may be used instead of Heptachlor. It, too, has a long residual action.

Fire ants are not mentioned elsewhere. They are a serious problem in the State, but I have not been bothered. I carry a supply of Heptachlor 5G in my scooter. All my men know I have it. They tell me about any ant hills or mounds they see.

Armadillos exist along the bayou that runs along one side of the golf course. They are no problem on the course, due, I'm told, to the control of insects and not necessarily due to the insecticide.

I always add a spreader-sticker with insecticide, even though it is not mentioned with each chemical.

The following may serve as a useful reminder:

3 tsp. = 1 Tbsp.

2 Tbsp. = 1 oz.

8 oz. = 1 cup

2 cups = 1 pt.

2 pts. = 1 qt.

4 qts. = 1 gal.

COMPARISON OF COMMON TO OTHER BERMUDAGRASSES

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Milwaukee, Wisconsin

Bermudagrasses are thought to have originated in tropical Africa, according to J. R. Stevens, because of the number of different types found there today. In that part of the world, bermudagrass and ants are closely related, and it is sometimes thought that ant migrations helped spread this species of grass through the Great Rift Valley in Central Africa. Bermuda has a long history and according to Dr. Robert Kneebone of the University of Arizona, was known in ancient India. There, it was credited with possessing aphrodisiac properties and at the same time being able to control venereal disease. Some of our new bermuda strains then might be called Love Goddess #9, rather than Tifton #328. Thus, when we plant bermuda, we could have a love potion and a prophylactic wrapped up in one package.

The earliest recorded history of bermudagrass dates to 1751, when it was introduced into the Savannah, Georgia area by Governor Henry Ellis. Though not recorded historically, many workers feel that the Spanish Conquistadores brought bermudagrass seed into the United States in the hay that was used to feed their horses.

The United States Golf Association Green Section, under Dr. Piper, established six plots of bermudagrass strains in Atlanta around 1918, one of which was a selection from Manchuria. In 1924, Atlanta bermudagrass was recognized as an established strain. Mr. P.D. Maxwell, at Dornick Hills Club at Ardmore, Oklahoma planted the Atlanta strain there and was quite pleased to report that only 100 days was required from planting to playing the greens of this "new strain."

Common bermudagrass is primarily adapted south of a line running from Kansas to Virginia. Some strains, however, do very well in the Kansas area. Some have even proven hardy during one or two (but not several) Wisconsin winters. U-3 was thought to be the most winter-hardy selection for quite a time, but recent tests indicate that other varieties do equally well or better. Some varieties cannot be grown north of Florida because of their susceptibility to winter injury.

Before World War II, bermuda improvement was primarily done through selection of different strains of common bermuda found in nature. After that period, Dr. Glen Burton led the way in producing hybrids that utilize the best characteristics in the find and coarser bermudas. The common type has a chromosome number of 36 or 40 depending upon which expert does the counting. This is usually Cynodon dactylon. The finer textured bermudas are of the South African Cynodon transvaalensis type with a chromosome number of 18 or 20. Hybrids of this cross have 27 or 30 chromosomes and because of this triploid characteristic produce no viable seeds.

Some of the bermuda species are well-known in the field today. Common bermudagrass, Cynodon dactylon has a chromosome number of 36

and can vary widely in its appearance and growth characteristics. The Royal Cape strain of this species was selected about 1930 in South Africa. It has become quite useful in the hot desert areas of the Colorado basin and is tolerant to saline soils. Hall's selection, C. dactylon vars. densus was selected in 1933 by T.D Hall at the Germiston Golf Course in South Africa. The giant bermudagrass found throughout the southwestern United States is a diploid chromosome number of 18. Another with the same chromosome number are stargrass, (C. plectostachyus). Florida grass, (C. transvaalensis), is another with a chromosome number of 18 or 20. It was discovered in 1907 and has been used as the male parent for most of the hybrids in use today.

Three species of bermudagrass produced stolons only with no rhizomes. These are also in the 18 chromosome group and are Cynodon bradleyi, Cynodon hirsutus, and Cynodon incompletus. None are in wide use today.

The earliest of the hybrids is Cynodon magennisii, which was discovered in 1922 by an African Magistrate. It has a chromosome number of 27 and although it is classified as a species, it is probably the result of a cross pollination between an 18 and 36 chromosome type.

World War II played an important role in the development of several fine textured bermudagrasses in use today. Before the war, Dr. Roy Bair of the Florida Experiment Station planted several test plots throughout the South Florida area, using common and South African bermuda types. The war, of course, prevented adequate maintenance or upkeep of these plots and during this period, they evidentally flowered, cross-pollinated and set seeds. In 1945, Bair went back to the original plots and re-established them under turf management. From these plots, came Bayshore (Gene Tift) and the Everglades varieties, which are natural hybrids between the common and South African type. In 1946, Bair selected the Ormond strain from Elinor Village and Ormond Beach, Florida, as a natural cross between the native bermuda and an Arizona type. The Magennis bermudagrass mentioned earlier is called Sunturf in the United States. It was released by several states as a variety in 1956.

The Texas bermudas were selected by Dr. James Watson and co-workers in the 1950's at Texas A&M. The Coastal Plain Experiment Station in Tifton, Georgia is responsible for several turf type bermuda-grasses being used today. Tiflawn (T-57) was released by Dr. Burton in 1952. It is the result of pre-World War II breeding program, growing wild through the war years, and tested as a turf type in the post war period. Tiffine (T-127) bermuda was released in 1953, and is the off-spring of a cross between Tiflawn and Cynodon transvaalensis from East Lake Country Club in Atlanta. Tifgreen (T-328) bermuda was released in 1956 and is the off-spring of a common bermuda strain from the Charlotte, N. C. Country Club and the C. transvaalensis mentioned above. Tifway (T-419) is apparently a natural hybrid found in a lot of seed from South Africa, that was planted in 1954. Tifway was released in 1960. Tifdwarf is the latest of the Tifton varieties and is said to be a mutation that occurred in early Tifgreen plantings. There are two sources of dwarf types. One, from the Coastal Plain Experiment Station, the other, from Southern Turf Nurseries in Tifton. It might be said

at this time, that both locations where Tifdwarf was discovered, were also early field tests of the Tifgreen. Samples sent to both places were selected from the edge of plots and could possibly be a mixture from adjoining plots in the original test plots at Tifton.

Other improved varieties now being used include U-3, selected by Golf Course Superintendent Lester Hall in the early 1930's in Savannah, Georgia. This was tested at the U.S.G.A.'s Arlington turf plots and was distributed among golf courses in 1946 and 1947. Uganda is a transvaalensis type that was brought into the United States in the early 20's. The sample release was brought to the United States from the Cairo, Egypt Golf Club in 1949.

Tufcoat is a 1962 release from the University of Maryland. This came from a group of South African seed sent by General Jan Smutz in 1942. It was selected for cold tolerance since it was the only strain to survive a -17°F cold wave. Other cold tolerant bermudas are being tested by Dr. Ray Keen at Kansas State University for use in the upper limits of bermudagrass adaptation.

Two of the most interesting bermuda varieties are the "No Mow" selections being tested at the University of Florida. Both originated at the Country Club of Mobile, Alabama and were descovered by Superintendent Bill Norrie, Sr. Most of the stolon and leaf growth is horizontal and requires a minimum of mowing. These selections make many seed heads as they are taken north, away from the gulf coast. Work at Texas A&M has already shown that these two selections are quite shade tolerant and produce better turf under moderate shade than in full sun. Not only will this enable them to be used in many areas that do not make for good bermuda turf, but also as a source of breeding stock for future hybrid development.

Bermudagrass selections are best for the purpose they are intended. Usually the finer types are more adapted to the southern regions, while the more cold tolerant strains fround in the north are coarser. Fineness and turf vigor indicates strong thatch production that is not always good. Thatched fairways are poor for good golf play, so some of the hybrids are questionable for this use, even though they are prettier. Greens planted to hybrids respond strongly to aeration and topdressing as well as vertical mowing. If these are smaller areas, however, they can be treated with the proper cultural techniques to good advantage. For large areas not subject to extreme traffic, common bermudagrass still remains the best choice. Many workers feel that if common bermuda fairways are given the intensive care hybrids demand, they would produce the high quality turf attributed only to the hybrid types.

(Presented to the Texas Turf Conference, December 1966)

RECORD KEEPING AND BUDGETS

Phil Huey, Superintendent
Parks Department
Dallas, Texas

In a recent issue of Park and Recreation Magazine budget was defined as a word used to describe a plan prepared by responsible agencies for financing an enterprise, public or otherwise over a given period of time. It was further described as a controlling financial plan for accomplishing a program of work. Until approved, however, it is a plan without force.

We are concerned not only with how the budget is compiled but how to gain approval of as much of the budget as possible and then to implement the portion approved.

OUTLINE OF BUDGET PREPARATION

A. How compiled

1. One person responsible
2. Several responsible

B. Budget reminders

Keep an active file of items, as they come to mind, which should be included in the budget. These cannot be thought of all at one time so these reminders are necessary.

C. Budget work sheets help outline budget needs (copy included)

D. How much time spent on preparation

1. How many weeks in preparation?
2. How many times reviewed?
3. How much deleted when reviewed if reviewed prior to being put in final form?
4. How presented in final form?

E. Final review and approval

1. Adequate explanations for all items
2. Are all who review the budget familiar with the operation concerned.
3. Is the budget discussed at its final review?

WHAT ARE THE PROPOSED ACCOMPLISHMENTS FOR THE YEAR

1. Labor distribution
2. Equipment use and cost
3. Proposed plans
4. New developments that must be included

BUDGET IMPLEMENTATION

How the budget is put to work and who is responsible for ordering the material or making organizational changes must be decided.

After approval, it is very important for those responsible for

its implementation that the material be ordered as quickly as possible. If it is a large department one man probably cannot order all the approved material and if responsibility for ordering items has not been delegated it should be, so that all items can be ordered on time and in the proper manner.

Once the budget is approved your most important mission is getting it moving so it then can be of some real value to you.

(Some of the record keeping forms used by our department were displayed and distributed to those interested.)

BUDGET WORK SHEET
MAJOR MAINTENANCE ITEMS
1966-67

BUILDINGS

ALTERATIONS	EST. COST	EXTENSIVE MAINTENANCE	EST. COST
Additional lighting	$_____	New floors	$_____
Additional Heating and cooling	$_____	New roof	$_____
Additional Plumbing	$_____	New plumbing fixture	$_____
Additional Rooms	$_____	New doors - screens	$_____
Additional storage structures (Bldg.)	$_____	New windows - screens, etc.	$_____
Additional shelving	$_____	New lighting fixtures	$_____
Additional _____	$_____	New paint - inside	$_____
Additional _____	$_____	New paint - outside	$_____
Additional _____	$_____	_____	$_____
Additional _____	$_____	_____	$_____
Additional _____	$_____	_____	$_____

GROUNDS MAINTENANCE

	EST. COST		EST. COST
Extensive grading (Equip. Rental)	$_____	Extensive Fill (Equip. Rental)	$_____
Extensive drainage	$_____	New Bridges	$_____
1. Ditches	$_____	New Roads (Gravel)	$_____
2. Storm Sewers	$_____	New Walks - Curb & Gutter	$_____
Extensive paving repairs	$_____		
Water Lines	$_____	Other Extensive Concrete Work	$_____
Electric lines	$_____		$_____
_____	$_____	_____	$_____
_____	$_____	_____	$_____

ADDITIONAL FACILITIES

	EST. COST		EST. COST
Swings	$_____	Slides	$_____
See Saws	$_____	Merry-go-rounds	$_____
Climbers	$_____	"V" Backstops	$_____
Electric lines	$_____	Picnic Tables	$_____
Permanent benches	$_____	Drinking Fountains	$_____
_____	$_____	_____	$_____
_____	$_____	_____	$_____

FURNITURE

	EST. COST		EST. COST
Chairs - side	$_____	Chairs - folding	$_____
Tables - recreation	$_____	Desks - office	$_____
Chairs - office	$_____	Ping Pong Tables	$_____
Jonsey Tables	$_____	Filing Cabinets	$_____
Adding Machines	$_____	Typewriters	$_____
Duplicating Machine	$_____	Kins	$_____
Music Systems	$_____	_____	$_____
_____	$_____	_____	$_____
_____	$_____	_____	$_____

EXPLANATION (if this spece is not adequate use back of sheet)

_____

_____

_____

_____

_____

Park or Building_____ Superintendent_____

MODE OF ACTION OF SYSTEMIC HERBICIDES

Dr. Joseph Hacskaylo
Plant Sciences Department
College Station, Texas

Systemic herbicides are chemicals that are absorbed at the site of application and subsequently translocated throughout the plant in amounts sufficient to kill it. These materials may enter the plant through the root, stem, or foliage and translocation within the plant occurs by way of the xylem, phloem, or both.

Differential selectivity of herbicides can be attributed to a number of factors. For example, some susceptible plants absorb and translocate much greater quantities of certain herbicides than do the less susceptible plants. Still others are resistant to certain herbicides because they can inactivate the chemical by enzymes. The susceptible plants, of course, lack this ability. Another important factor in selectivity of herbicides is sometimes related to the stage of growth of a given plant. Often, seedlings and young plants can be controlled by a given herbicide but as they mature, they become resistant to the chemical. On the other hand, if plants are well fertilized and in a rapid state of growth, they tend to be more susceptible to the auxin type herbicides than are those that are slow growing and that have low nutrient status.

According to some research workers, the mode of action of some herbicides is specific and phytocidal activity can be attributed to a single biological response. However, more often than not, phytotoxicity appears to be due to a combination of physiological disturbances rather than to a specific effect. Some of the responses of plants to herbicide may be listed as follows: Disruption of cell division and cessation of growth; inhibition of cell and tissue development (differentiation); chlorophyll destruction; enzyme inhibition; production of toxic metabolites; and the creation of a hormonal imbalance.

BUILDING NEW GOLF COURSES

Dr. Marvin H. Ferguson
Mid-Continent Director
U. S. Golf Association, Green Section
College Station, Texas

The last few years have seen a very rapid growth in the golf course population.

The latest report from the National Golf Foundation shows an inventory of 8,667 golf courses. This number is authenticated by signed questionnaires. The National Golf Foundation is trying to locate any others that may exist.

There were 532 courses (standard and par-3) in some stage of construction at the year end (September 30, 1966). This is down 14% from last year. In 1966, the figures from Texas showed that 17 new courses were opened. Of these, 11 were standard length courses and 6 were "par-3." Texas ranked eighth in the nation in new courses opened. There were 19 courses under construction in Texas at the end of the year.

Regardless of the rapid building trend, the majority of the golf courses in the United States were constructed in a day when maintenance practices were quite different than they are today. Labor was cheaper and equipment was less sophisticated.

Recent surveys indicate that approximately 70% of golf course maintenance budgets are spent for salaries, wages, and payroll costs. It therefore becomes increasingly important to eliminate as many as possible of the unnecessary labor requiring features of the golf course or to modify features so they can be maintained with larger equipment. These deletions and modifications however, must not require the sacrifice of golf values.

Some considerations in design and construction which would ease maintenance are outlined.

1. Tees
    a. Should be large enough to permit frequent movement of tee markers. Trend to long tees - Try making broad enough to allow lateral movement of markers.
    b. Sloped sufficiently to allow ready drainage but not enough to give the golfer a feeling of uneven ground. One percent to 1½ percent slopes.
    c. Relatively low with gentle slopes blending into surrounding terrain.
    d. No sharp corners that would be scalped by gang mowers.

2. Fairway bunkers

   a. Slopes should permit maintenance with multiple unit mowers.

   b. Slopes within the bunkers should not require a great amount of raking to keep sand in place.

   c. Drainage from these bunkers should be provided for.

   d. Should be so situated that surface water from surrounding area will not run into the bunker.

   e. A design that will permit natural edges as opposed to trimmed edges is preferable.

3. Bunkers around the greens

   a. The same considerations listed for fairway bunkers should be observed.

   b. The location of bunkers around greens is a controversial matter. Two schools of throught.

      (1) Locate bunker close to the green and keep traffic our of the area.

      (2) Locate bunker far enough from green to allow passage of multiple unit mowers.

      Both of these arguments have merit. The decision must be reached after a study of each situation. It seems most likely that a combination of the two concepts may be most adaptable - at any rate, provide for maintenance in the design stage.

4. Plantings

   a. Trees and shrubs generally should be arranged in natural appearing groups rather than in straight lines.

   b. Species should be chosen which require relatively little care and which do not produce large amounts of trash.

   c. Shallow rooted trees such as maples and some of the elms should not be planted close to greens or tees.

   d. Thought should be given to location so that the operation of maintenance equipment is not hampered.

5. Traffic flow - In many cases, this factor has been overlooked by designers.

   a. Features of the course should be so arranged that they do not channel traffic into an area to such an extent that turf is damaged. If it is channeled - then provision should be made to handle it.

   b. The ends of bridges, etc., cannot escape the concentration of traffic, but it is possible to keep traffic out of narrow areas such as that between a bunker and a green by proper location of these features in relation to each other.

c. Parking areas for motorized carts are being incorporated in some plans.

d. Continuous pathways are finding favor. Location is extremely important to keep them from interfering with golf.

6. Greens - This feature has been left until last in the discussion because it is most important.

a. Design

(1) Trend is toward larger greens - Let's not allow it to get out of hand!

(2) Cup setting should be possible on practically the entire putting surface. Object - plenty of cup space without extra large greens.

(3) Slopes should provide interest but should not be so severe or changes in contour so sharp as to cause maintenance difficulties.

(4) Slopes around greens should be gentle.

(5) The green should be so situated as to never be subject to overflow of water from surrounding terrain.

b. Soil considerations

(1) Drainage is the first consideration.

(2) Resistance to compaction is important.

(3) While green must be well drained, it should not be "droughty."

(4) Must hold a shot without being too wet.

(5) Must support a good stand of grass.

c. Construction procedure

(1) Lay tile in a suitable pattern after the subgrade has been established. The contours of the subgrade should correspond to the planned contours of the finished green.

(2) A gravel blanket (1/4 to 1/2 inch aggregate) should be placed over the tile lines and over the entire surface. Minimum thickness for this layer should be 4 inches.

(3) Because of the tendency of soil to migrate downward into gravel, a layer of coarse sand 1½ inches in thickness may be used over the gravel blanket. This is particularly desirable if the underlying gravel is coarse. If fine gravel is used, the sand may not be necessary.

(4) Mix soil off the putting green site. Place carefully on the prepared base.

(5) Save an ample supply of the soil for future topdressing.

(6) Sterilize putting green after soil is in place by the use of methyl bromide or other suitable sterilant.

(7) Firm the soil, rake it smooth, and firm it again until the surface is smooth and uniformly firm.

(8) The green is now ready for planting.

The points outlined with respect to the building of greens have come to be known as the "Green Section Specifications." In addition to this, we need some sort of overall "model" specifications which can be used as a guide (a checklist of matters to be considered in other phases of golf course construction).

Golf course design and construction is not a young profession but growing pains of recent years have brought many people into the field who do not have adequate background. Some lack an understanding of agronomic principles, some lack an artistic nature which is necessary to pleasing design, and some lack a thorough knowledge of the game and the strategic principles involved.

Because of the varied background of the men involved, the acceptance of definite specifications is quite difficult to accomplish. Nevertheless, the day must come when work on golf courses is done according to rather precise drawings and specifications.

Many new courses reflect almost total lack of imagination in the creation of problems for the golfer. Much design is stereotyped. We simply have a drive, a pitch, and two putts.

A good test of golf should present many types of problems and should require versatility on the part of the golfer. It should at once present challenge to the expert, but permit pleasurable play by the inexpert.

EXAMPLE:

(1) Tee markers set near tree line to dictate slice or hook.

(2) Requirement for pitch and run shot.

(3) Requirement for placing a tee shot accurately.

(4) Better use of big challenges, with the promise of big rewards to one who successfully accepts the challenge.

We need more imaginative design for play of the game and more conservative design for maintenance. I believe the two aims can be reconciled.

MANICURING TURF

Roger Thomas
Jacobsen Manufacturing Co.
Racine, Wisconsin

(Note: The following talk was given entirely by the use of slides. Each question or subject was treated with a number of different slides.)

The subject I have been assigned is, in itself, a very broad one and the first question that comes to mind is why should we have such well-groomed courses. The money that the member pays to a particular club in the form of golf fees or dues makes him feel personally that he pays more than enought to have the best course around. Secondly, courses that are well-groomed and well-kept have a tendency to receive better treatment by the golfers. Isn't it true that we tend to treat the better looking things in life with much more care? To get into the subject of manicuring turf, I thought it best to simulate playing a round of golf. Our subject starts at the entrance.

As we enter the club, do we see neatly groomed turf and plantings that are attractive? Is the golfers first impression that someone who really cares is working here? As we enter the parking lot, is it neat appearing or do we observe all the trash cans from the dining roon? Is there paper flying or lying around? Have we made a good impression by the appearance of the Pro Shop? Are the caddies handing around the Pro Shop like they would at an ice cream parlor? First impressions are very important! As we walk to the first tee, is the gully cleaned up or has it become the collection point for gum wrappers, cigarette packages, paper, tree branches, etc.? If the gully is inaccessible or is difficult to mow and maintain, have we given any consideration to decorating it with shrubbery, trees or plantings?

Are the grass clippings on the tee being picked up? In other words, is the golfers first impression of your golf course one that will cause him to treat the turf with a little more respect than a "Sunday hacker?"

Let's tee off! Before we hit that first shot, what do we see? Have we trimmed the trees properly so that it isn't impossible for the average or better than average golfer to reach a position for a good second shot? Let's move along down the Fairway. Is there a fence along one side of the Fairway? Are we spraying the weeds and reducing trimming costs at the same time?

What kind of a lie does the ball have? Is thatch being controlled in the Fairways? Is there a drain somewhere in the Fairway that it might be best to decorate than spend the time trimming around it each mowing? Let's go further down the Fairway. Is the golfer impressed by the smoothness of the turf or the clean appearance of the Fairway? In overseeding, has the turf been prepared by removing thatch and cutting slits into the ground for a good germinating bed? Unless there is a tournament going, has consideration been given to flag placement? There

aren't many places that one can put a flag on the average green, but on busy days, flag placement can slow or speed up a play.

How do the traps look? Do they have that "shaggy dog" look? Are they being trimmed by hand? Are trap trimmers being used to reduce labor cost? Have you taken care in the selection of the products that you are using? What about old equipment? Can you really afford to repair it? Have you used special turf equipment in places where the turf can be observed very closely by members or golfers? Are you keeping equipment sharp to avoid the brown color casts from dull blades? Are you putting the right machine on the job to spend the minimum amount on labor as compared with using a very small machine to do a large job? Have you trained your operators on hills and bunkers to push rotaries and not pull them? Have you trained them to exercise care so that costly accidents aren't plaguing your club? Have you checked on the inaccessible areas and found a way to cut them to avoid over turning tractors? Have you really given a study to maximum use of equipment with a minimum of labor cost?

I am sure you've done many of these things. Still have problems? Everyone has problems. As a review of these, just consider the problems of yearly floods along the Mississippi. Consider the number of temporary bridges that are required and build during a time when normal maintenance should be done. Everyone has some golf car damage. Maybe your's isn't really as bad as the fellow at the club next to you. Most water systems give some problems but they can be solved with expert advice. Problems concerning winter kill, brown patch, dollar spot, etc., appear yearly. Many clubs in metropolitan areas have the problems of vandalism and most golf courses are plagued with a lack of trained labor unless they can match the rates being paid by industry.

But with all of this, our's is a good lot because without problems, possibly we wouldn't be needed. Most Greens Chairmen today realize that manicuring turf involves a great deal more than merely cutting it. Members, too, are beginning to become aware of the Superintendent's position at a golf course. The very fact that you attend conferences and continue to educate yourselves will help insure your position as a leader in producing top quality turf.

Good luck for the Growing Seasons ahead.

ALL WEATHER SURFACES FOR RECREATIONAL AREAS

Bob M. Gallaway
Civil Engineering Dept.
Texas A&M University
College Station, Texas

The booming economy of the "Great Society" has placed the greatest demands in the United States' history on the recreational facilities of the country. The impact will be felt more critically in Texas beginning with the 1967 vacation season than would be expected for the nation as a whole. This will come about due to Texas' move to daylight saving time. The short term (one to four hours) use of local recreational facilities will increase materially in Texas during 1967. Coupled with this increased demand by short distance users will be an increase in usage by out-of-state tourists.

If Texas is to continue to attract an ever increasing flow of the vacation dollar, a well orgainzed and integrated plan for further development of recreational areas must be put into effect immediately. To wait until next spring to start the build up could result in considerable damage to Texas' reputation as the "Funteer State."

A most important aspect of this overall plan is the development of a fine system of all weather surfaces for these recreational areas. The time has passed when a family is content to wallow in dust or wade through mud just to be away from a soft chair and color T.V. in an atmosphere of air conditioned comfort.

The bicycle path, the bridle path and the golf cart path must be added to the walks, parking lots, and access roads of the rapidly growing recreational areas. These all weather surfaces may take on any one of many forms, but they must all have beauty and they must be serviceable. To be attractive, the designs should be carefully worked out by competent Landscape Artists, and to be serviceable, the designs will require the services of an Engineer schooled in soil mechanics and pavement design.

I have selected a group of color slides which will typify a few of the many variations of all weather surfaces. There are many other examples, but time does not allow me to show them.

These slides include examples of plant mixed asphalt paving used to build walks and trails on Brookhaven Country Club, the Dallas Athletic Club and on the Campus of Texas A&M University. Portland cement soil stabilization of park roads and walks was included as well as several slides on the use of brick and blocks for patios, drives and walks.

There is very limited information available on the design of the very light duty surfaces under discussion. There are no theoretical procedures; therefore, seasoned judgement must be used, at least for the present time. Actually, for the very low wheel loads involved for the paths and walks, one needs to design primarily for stresses caused by expansion and contraction due to daily changes in temperature and moisture.

The following design for bicycle paths was taken (with some modification) from a paper prepared by C. R. Foster, Coordinator of Research for the National Asphalt Pavement Association.

"The design for bicycle tracks does not justify the extensive number of soil types used in road design and subgrades are categorized into three groups as listed below. The effect of poor drainage, severe

frost conditions, highly elastic, or highly expansive soils are recognized in the categorization.

Class	Material	Unified System	AASHO System
Very Good	Gravels and Sandy Gravels	GW,GP,GM,GC SW,SP,SM,SC	A-1, A-2-4 A-2-5, A-2-6
Good	Silts & Clays	ML,CL,OL,MH CH,OH	A-4, A-5, A-6 A-7-5, A-7-6
Poor	Silts & Clays*	ML,CL,OL,MH	A-4, A-5, A-6 A-7-5, A-7-6

*Silts and clays rated poor only under the following conditions:

a. When they occur in low lying areas where the natural drainage is very poor and will not be improved.
b. Where the conditions of water table and climate are such that severe frost heave can be expected.
c. Where high percentages of mica-like fragments or diatamaceous particles produce a highly elastic condition. This would occur mainly in A-5 (ML and MH) soils.
d. Where it is desired to "bury" highly expansive soils, usually A-7-6 (CH), deeper in the section to limit the effects of seasonal variations in moisture.

Full depth hot-mix asphalt pavement is recommended because it provides the best possibility of success. Placement directly on the subgrade is recommended as granular cushion course provide no benefit and in many cases serve as water reservoirs. The following thicknesses are recommended:

Subgrade	Total Thickness
Very Good	3"
Good	4"
Poor	6"

Regular state highway mixes should be used provided they are dense graded. A mix that will compact to 10% or less air voids is dense graded. The surface course should be a relatively fine mix, say 100% passing the 1/2" screen or finer, to provide a smooth texture. Asphalt content should be a half per cent higher than used for roads and streets since the bicycle path will be subjected to lighter traffic than the road. Hot-mix asphalt base or binder course can be used below the surface course where economical.

Recently published data show that thick lifts compact better than thin lifts because the temperature distribution from top to bottom of the lift is more uniform in the thick lifts. Therefore, construction should be in one lift where it is economic and surface smoothness tolerances can be met. Otherwise, two lifts should be used. Where two lift construction is used, the surface course should be 1-1/2" thick to insure good compaction.

Most asphalt pavement is placed with spreaders and mixing plants are geared to the high rates of production that can be achieved with spreaders. Conventional spreaders can place widths ranging from 8' to

12'. If narrow widths are used that preclude the use of conventional spreaders, the costs of hand laying may boost the price per ton of the mix to the point where the narrow hand spread walk will the approach the cost of a wider machine laid walk." (C. R. Foster, 31 March 66)

It is the writer's opinion that the total thickness listed above for the three classifications of subgrade are quite conservative. I would suggest 2", 3", and 4" for the described subgrades and I would further add that the subgrade be compacted to 95% of Standard Procter density before the surface is placed. To minimize grass and weed intrusion, the prepared subgrade should be treated with sodium trichloracetate (Sodium TCA) at the rate of 200 pounds per acre, or one pound for 200 square feet. A source of supply for this chemical is Dow Chemical Co. in Houston. Sodium TCA is dissolved in water at the rate of one pound in two and one half gallons of water for application. This chemical will kill trees, so care must be exercised in its use. Normally, no under treatment of a walk or path is required under trees, since grass and weed growth beneath trees is limited.

Minimum maintenance is an important consideration for paved areas. An increase in first cost to do the job properly is almost always justified. The added extra of long term good appearance will pay big dividends.

This limited coverage of this subject would be incomplete if I did not mention the availability of many of the special paving materials now on the market. Such materials as Saf-Pla, Grass-Tex, and Lay-Kold are well known; others are in the development state and/or the future. This includes synthetic stone of various colors suitable for park roads and paths.

Special designs for golf carts are possible. One attractive approach would be to design a cart path that would support vegetation and at the same time be all weather for carts. Such a path should not detract materially from the natural appearance of the golf course. In areas of concentrated traffic, this same design would be treated with sodium TCA and topped with, say, 1-1/2 inches of dense grade asphalt paving.

Highly serviceable walks may be prepared with good quality sandy gravel base of 3 to 4 inches thickness topped with 1-1/2 inches of hot-mix cold laid paving materials. Such walks exist on the Texas A&M Campus and these have been in service for about 15 years. Where intrusion from grass does not exist, these are in very good condition.

In summary, it may be said that we have an urgent problem to solve to meet the state's demand for all weather surfaces for recreational areas. Many materials are available to suit the varied design conditions. Technical know-how and adequate construction equipment exist to handle this important task. Work should begin immediately on the job.

PROPER USE OF INSECTICIDES FOR CONTROL OF INSECTS ON LAWN GRASSES

Neal M. Randolph
Entomology Department
Texas A&M University
College Station, Texas

There are many formulations of insecticide preparations but the most common are emusifiable concentrates, solutions, wettable powders, dusts, granular and insecticide-fertilizer mixes. Of this group granular, wettable powders and insecticide fertilizer mixes probably are the most commonly used on lawns and golf courses. Also these are usually considered to be the most safe formulations in regard to the applicator as well as to those persons frequenting the treated areas. However, the toxicities of the insecticides to humans and the phytoxicity to plants treated vary greatly in regard to the type of insecticide to be used. The elapse of time between treatment and the use of the area treated is an important factor.

A question frequently asked concerning the use of insecticides and other pesticides is, "How toxic is the chemical to humans?", or "Is this insecticide more dangerous than DDT?". The standards in common use to compare toxicities are based on tests with various small animals. White rats generally are used to get comparisons on the lethal amounts by eating, and rabbits for the amounts by way of skin absorption. The amounts are usually given as LD_{50}. This means the size of the dose which is lethal to 50 per cent of the test animals. The LD_{50} is usually expressed in terms of milligrams (mg.) of toxicant per kilogram (kg.) of body weight of the test animal (mg./kg.). One milligram (mg.) is equal to .000035 ounce and one kilogram (kg.) is equivalent to 2.2 pounds. Using DDT, for example, the amount which needs to be ingested (or eaten) in a single dose to cause death to 50 per cent of the test rats is approximately 250 milligrams of technical DDT per kilogram of body weight of the rats. Thus, we say that the acute oral LD_{50} of DDT to rats is 250mg./kg. Likewise, the acute oral LD_{50} of parathion to rats is about 3 mg./kg., while that of malathion is approximately 1500 mg./kg.

From this we see that parathion is considerably more toxic to rats than is DDT or malathion. It does not necessarily follow, however, that parathion is 83 times as hazardous to use as DDT or 500 times as hazardous to use as malathion. The spray or dust concentration of parathion generally used for insect control is considerably lower than for DDT or malathion. Also, parathion residues break down much more quickly than those of DDT, chlordane, dieldrin and many others. In addition, the figures given here are for rats, and all animals do not react the same as rats.

The acute dermal toxicity figures are usually higher than oral toxicity ones. It usually takes much more insecticide put on the skin to cause death than it takes to kill by eating the insecticide. The dermal toxicity figures are probably the more important ones since in spray or dust applications most of the insecticide contacted is that which gets on the skin.

Phytotoxicity is the degree of injury an insecticide, or any other product, may cause when applied to plants. Generally, this is known only by experimentation. It is reasonable to suspect that certain chemicals are phytotoxic to herbaceous type plants. We have found many insecticides toxic to certain plants and the organophosphorus compounds perhaps are the most common. Frequently, the type and stage of the growth of the plant, temperature, time of day or night the chemical is applied, the type of formulation and amount of dilution with water are collectively or separately determining factors. Most insecticides perhaps would be less toxic to tender grasses if applied during the late afternoon or early evening and, in several cases, it may be more effective for controlling certain insects.

Many of us do not or carelessly read the label on the package and poor results from the use of pesticides for control of insects frequently occur. Also, failure to follow directions may be dangerous to the applicator as well as to others who may frequent the treated area. The Federal Insecticide, Fungicide and Rodenticide Act requires that all products be registered with the U. S. Department of Agriculture before they may be marketed through the channels of interstate commerce. Also each product must bear a label including the following information:

1. Name and address of the manufacturers.
2. Name brand or trademark of the product.
3. Net content.
4. Statement of the proper ingredients, including the percent by weight of the active and inactive ingredients.
5. If product is highly toxic to man it must bear a poison label in red and the skull and crossbones.
6. Also, if poisonous to man, an antidote is required on the label.
7. Adequate directions and necessary precautions must be given.

These statements include the guarantee that the product, when properly mixed and applied, will control certain named insects. The manufacturer, in order to comply with the Act, must prove that the recommendations are accurate and dependable before registration of the product can be obtained.

Most states require essentially the same information on labels as required by the U.S.D.A. even to be marketed through channels of intrastate commerce.

LAWN INSECTS

Insects	*Description and type of damage*	*Treatment* (Listed alphabetically) (Follow manufacturer's directions for mixing and applying sprays)		*Remarks*
White grubs (larvae of May beetles)	White with brown head and 6 legs. One to 1½ in. long. Grubs feed upon roots and underground tender parts of plants.	Dusts: Wettable powders— 6 oz. of 25% Aldrin; or 10 oz. 40% Chlordane; or 4 oz. 25% Dieldrin; or 5 oz. 25% Heptachlor per 1,000 sq. ft.	Sprays: A. Aldrin B. Chlordane C. Dieldrin D. Heptachlor	Apply dust on lawn and sprinkle with water to soak into soil. Apply spray directly onto soil at rate of 25 gal. per 1,000 sq. ft.
Pillbugs or sowbugs	These pests are not insects but often cause damage to tender plants. Light-gray to slate-colored and about ½ inch long. Roll up in shape of pill when disturbed.	Commercially prepared baits may be used. Dusts: A. 5% Carbaryl (Sevin) B. 5% Chlordane C. 5% DDT D. 2% Lindane	Sprays: A. Carbaryl (Sevin)	Apply dusts and spray directly to feeding area. Broadcast baits in early morning or late evening.
Snails and slugs	Grayish to grayish-brown, legless, slimy and soft-bodied slugs, ½ in. to 4 in. long. Snails are made up of spirally coiled, conical shells about 1 in. long.	Use commercially prepared baits containing metaldehyde. Dusts: A. 5% Carbaryl (Sevin)	Sprays: A. Carbaryl (Sevin)	Broadcast bait in late evening or early morning.
Termites	Small trees sometimes are attacked by termites. They burrow into roots and crowns of plants. Worker termites are wingless, soft-bodied and white with dark jaws.	Dusts: A. 10% Chlordane B. 10% DDT C. 2½% Dieldrin	Sprays: A. Chlordane B. DDT C. Dieldrin	Also, dust soil surface around plant with wettable powder. Water plant to soak insecticide into soil.
Chiggers (Redbugs)	The young chigger, known as a larva, is a very small, pale yellow, six-legged mite which attaches itself to the skin of man or other animals. The preferred feeding locations on man are parts of the body where clothing fits tightly. They insert their mouthparts in the skin and inject a fluid that causes painful swelling and itching. They become engorged in about 4 days, drop off, change to nymphs and finally adults, neither of which is parasitic.	Dusts: A. 10% Chlordane B. 1% Lindane C. Sulfur D. 10% Toxaphene	Sprays: A. Dieldrin B. Lindane C. Toxaphene	Apply dusts or sprays of wettable powders or emulsifiable concentrates to grass and ground litter where chiggers are present. Sprays generally are more effective. For small areas, use a compressed-air or knapsack sprayer and apply 2½ to 3 qt. per 1,000 sq. ft. If dusts are used, apply 10% chlordane or 10% toxaphene or 1% lindane at 20 to 25 lb. per acre (approximately 1 to 1¼ lb. per 1,000 sq. ft.). Apply sulfur at rate of 10 lb. per 1,000 sq. ft.

Ants	Several species may become pestiferous in home lawns. Size of ants varies according to species—fire ants may be as small as ⅛ in. long; agricultural (red) ants, as large as ⅓ in. long.	Dusts: A. 5% Chlordane B. 2½% Dieldrin C. 2½% Heptachlor Mirex bait (for fire ants only)	Sprays: A. Chlordane B. Dieldrin C. Heptachlor	These materials also are available in granular formulations. Use all formulations according to directions on manufacturer's label.
Fall armyworm, Sod webworm	Damage lawns by feeding on leaves and stems of grass. Fall armyworm has distinct, inverted white Y on front of head. Damage first appears as whitish patches in lawn where leaves have been skeletonized. The sod webworm is a dingy white larvae about 1 in. long when grown and is marked with prominent black spots. Silk-lined tunnels of earth near the soil surface are indications of the presence of this pest.	Dusts: A. 5% Carbaryl (Sevin) B. 5% Chlordane C. 2½% Dieldrin D. 10% Toxaphene	Sprays: A. Carbaryl (Sevin) B. Chlordane C. Dieldrin D. Toxaphene	Repeat application if new infestation develops.
Chinch bug	Primarily a pest of St. Augustine lawns in eastern half of Texas. Adult is 1/6 to 1/5 in. long with black body, reddish-yellow legs and fully developed wings. Each front wing is mostly white, but is marked with an irregular black patch at the middle of the outer margin. Newly hatched nymph is bright red and has a whitish band across the back. Adults and nymphs suck the plant juices, resulting in browned areas in the lawn. Injured areas frequently are first noted along edges of the lawn.		Sprays: A. Carbophenothion (Trithion) B. Diazinon C. Ethion	Irrigate lawn before spraying to aid in penetration of spray through the grass mat. Granular materials may also be used. Water lawn thoroughly following application of granules. Several commercial combination sprays are effective. Follow directions on the label. Repeat application as necessary when reinfestations appear. Use 15-25 gallons of spray mixture per 1,000 sq. ft. of lawn area.
Bermudagrass mites	These tiny, eight-legged pests have caused considerable damage to bermudagrass lawns in West and Northwest Texas during the last few years. Stunted internodes are characteristic symptoms of injury. Lawn develops a generally unhealthy appearance and makes slow growth. Individual mites are difficult to see without magnification.	Dusts: A. Sulfur (10 lb./1000 sq ft.)	Sprays: A. Carbophenothion (Trithion) B. Diazinon C. Ethion	Two applictions 10-14 days apart may be necessary for most effective control. Use 5 gallons of spray mixture per 1,000 sq. ft. of lawn area.

Caution: ALLOW LAWN AREA TO DRY THOROUGHLY AFTER SPRAYING BEFORE ALLOWING CHILDREN OR PETS TO PLAY ON THE GRASS

USE OF LIME ON GOLF COURSES

Howard S. Mitchell
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Dr. McBee assigned me the responsibility of discussing with you the use of lime on golf courses. First lets look at lime in general. It is put on soil for two purposes; one is to correct the soil acidity and the other is to furnish calcium and/or magnesium. In Texas most of our lime come from the Edwards fault. This fault starts at New Braunfels and goes through the Austin, Temple, Cleburne, Arlington, Chico, and Sherman areas. It breaks out again at Hugo and Idabel Oklahoma. Then there are some deposits around Burnet and in the hill country of our state. So any lime you purchase will come from the areas I have just named. Since most of the lime is needed in the eastern part of Texas freight is a very large factor in the lime industry and plays a great deal of importance in the price.

With this as a brief background, lets look at lime from the what, when, where, why, and how angles.

The "what" part includes the chemical and physical properties of lime. There are two basic types of lime; they are calcium and dolomite. The amount of acid that limestone can neutralize is determined by the chemical analysis of the lime, pure calcium carbonate ($CaCo_3$) has been chosen as a standard. Thus, calcium carbonate is said to have a calcium carbonate equivalent of 100%. All other chemical compounds found in lime are rated against calcium carbonate to determine the amount of acid they will neutralize. Since magnesium carbonate ($MgCo_3$) has the ability to neutralize more acid per pound than calcium carbonate, it has a calcium carbonate equivalent of more than 100%. An example of the calcium carbonate equivalent is:

The sample tested out to be---

$CaCo_3$	-	54%
$MgCo_3$	-	42%
All Other	-	4%
		100%

The molecular weight of $CaCo_3$ - 100
$MgCo_3$ - 84
(These are chemical constants - always the same)
We have to convert the $MgCo_3$ to $CaCo_3$ so we take $100/84 = 1.19 \times 42\% = 50\%$. Therefore, the $MgCo_3$ is 50% $CaCo_3$ equivalent. This sample would be 104% $CaCo_3$ equivalent. The reason I brought out this point is because when you buy your lime and the salesman says, "Our lime is 104% calcium carbonate equivalent", you will know that it has some magnesium in it.

The speed that the lime reacts with the acid in the soil is also influenced somewhat by the chemical analysis of the lime. The more magnesium carbonate in the limestone the harder the stone. The stones that contain a very high percentage of magnesium are usually very hard and granular and tend to resist a chemical reaction with acid. The stones with a high

percentage of calcium carbonate tend to be soft and chalky and react rapidly with acid. The most important factor in determining the speed of the reaction with acid is not the chemical content of the stone, however; but it is determined by how finely the stone is ground. Now we get to the physical phase of lime. The finer the liming material is ground the faster it will neutralize the acid in the soil. All lime is made up of various size particles. In an effort to assign value to the various particle sizes found in limestone, Ohio State University has developed the following efficiency rating system:

Particle Size	Efficiency Rating
Material passing a 60 mesh sieve	100%
Material passing a 20, but not a 60, mesh sieve	60%
Material passing a 8, but not a 20, mesh sieve	20%

From this it can be seen that material larger than 20 mesh is of limited use to you. I have just explained that the "what" of lime is really the chemical analysis and the finess of grind.

The "where" part of lime means, where do we put out lime. You should get a soil test to determine the pH of your soil. I might add here, that soil tests are your best tool in planning your overall fertility program. Most of the plants you will have on your golf courses will grow well with a pH as low as 6.0. However, to get the full benefit of your phosphorus in your fertility program a pH of 6.5 and above is more desirable. I will make this suggestion, keep fairways and greens at about pH 6.5 for good grass growth and if clovers or other legumes are wanted in the "Ruffs" get the pH to 7.0 or above. The heavier, more clay, your soils are the more lime you will need to neutralize them. The "where" in relation to the soil should be mentioned. Lime differs from other fertilizer material, in that the grass roots can not grow through the acid soil to reach the lime, and just a few roots have to reach the fertilized area for the whole plant to benefit.

Now lets look at the "when" part of lime. Lime is referred to as a slow acting material. Therefore, you need to put it out about six months before you can expect it to go to work. There are some advantages to lime's slow reaction; one is that the lime will last from three to five years depending on the quality and quantity of lime you use. The pH and the soil structure have some bearing on lime's slow reaction also.

We have covered many of the "why" parts of lime already, but lets look at them again briefly. Lime supplies calcium and/or magnesium, reduces the acidity, helps other fertilizer work better, makes soil microbes more active, and makes soil easier to work. I like to refer to the "Rolaid" TV commercial-----The soil can be the stomach and lime can be the "Rolaid". Lime just makes the soil feel better and, therefore, ready to do you a better job.

The "how" part of lime is rather difficult to explain. In your situation, you will probably not use large spreader trucks but will use something smaller. I would suggest that you use some kind of distributer that will give a real even coverage. You could use a fertilizer distributer that has a "whirling device" on it. This would give you beter coverage and more evenly distribution.

I will close with this summary:

1. Determine the amount and the kind of lime needed.
2. Keep the fairways and greens a little on the acid side (pH 6.5) to keep out undesirable plants. The "Ruffs" can be as high as pH 7.0 or above.
3. Use a fine ground lime for faster action.
4. By keeping the soil at the right pH the other fertilizers will respond better.
5. Spread your lime so it will get an even coverage.

GOLF COURSE
PROGRAM PLANNING AND HANDLING

W. T. Ingram, Superintendent
Corpus Christi Golf Center

A beautiful golf course is the ultimate aim of all of us. To accomplish this requires organization and planning our labor, materials and equipment, within the limits of a budget may run from ten thousand to one hundred thousand dollars a year.

The most important item of a budget is labor. Salaries are paid to a crew of men who are supposed to maintain a golf course to the standards set by the golf course superintendent. A good crew is composed of men that are dependable, thrustworthy and conscentious.

At the Corpus Christi Golf Center, the complete crew is composed of seven men. Five men are trained to do the routine work of mowing greens and fairways, changing cups, picking up trash and raking traps. The early morning schedule is completed in three hours or less. Tees and fringes are mowed three times a week. While mowing tees and fringes, the men are instructed to check and trim sprinkler heads around the greens. The fairways are mowed twice weekly in season. The men mowing the fairways are instructed to be polite and considerate of the players. Included in the duties of these men is fertilizing greens and spraying. The men entrusted with this responsibility have a thorough knowledge of the equipment used and a respect for the chemicals they apply.

The other two members of the crew are the foreman and the mechanic. The foreman is proficient in all the jobs performed and assists in the supervision of the remainder of the crew and their duties. The mechanic is skilled in small engine repair and has a sharp eye and touch for setting mowers. All mowing equipment must be kept in good working order, cleaned and painted. I personally check each piece of equipment to see that nothing is neglected. A dull mower can cause more bad greens than all the problems that may be developed by Mother Nature. A careful check is maintained on the cost of operation of each piece of equipment to see that operational costs do not exceed the value of the equipment. Preventative maintenance pays dividends over curative measures.

Once each week all golf carts are washed and greased. Batteries are cleaned and checked. Minor repairs are made at this time. Our golf carts are in excellent condition and further illustrates that being particular pays off.

Labor continues to represent approximately 70% of grounds expenditures. The training and retaining of key personnel is better economically than off season lay offs and slow spring starts because of green help. It is important to point out to your crews the beauty of the golf course and the improvements and increased beauty of the course brought about by a little extra effort and care. A man working for eight hours pay is not enough. He must have pride in his work to achieve the beauty we want and playing conditions todays golfer expects.

To help overcome rising labor costs we must streamline and mechanize our operations wherever possible. An automatic watering system is installed at the Corpus Christi Golf Center. Approximately five minutes time is required each day to regulate and control the water requirements of the golf course, This system replaces two men and saves approximately 7200 man hours per year.

The cost of supplies and materials must be controlled by careful ordering, measuring and experimentation to determine the actual requirements of chemicals for your turf. At the Golf Center we have very little fungus. Therefore, fungicides are sprayed only three times a year. Insecticides must be used every two or three weeks. Sodweb worms are the most persistant and more than the birds can control. We assist the birds in their control program of the sodweb worms with carefully applied amounts of insecticides.

After establishing the chemical needs for the turf and soil at the Golf Center, application of fertilizers is calculated to satisfy these requirements and promote grass of a good color and texture. The limitation of a budget is an important factor here and keeps us in line.

Sand and topsoil are ordered as needed for traps and topdressing. Experience is the best reference in this category. The months of green renovation are known well in advance and orders are placed early to prevent the lack of good topsoil being available when needed. Winter seed falls in line with topsoil in that needs are easily determined and we only have to hope the price has not increased from last year.

Program planning as indicated is advantageous to the development of a beautiful golf course. Thoughtful plans, dilligent attention to costs, careful supervision of men and equipment, and a genuine respect of turf conditions and player reaction summarizes the requirements for developing a great golf course and the satisfaction of a job well done.

GROUND COVERS IN LIEU OF GRASS

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The finest ground cover available is an unbroken weed free area of turf. "Ground cover," however, is a "use" grouping of plants rather than a group based on botanical or horticultural characteristics such as trees, shrubs, or vines.

Essentially, ground covers are low-growing plants that spread by underground or above-ground stems or that have inherent trailing growth habit. As these plants grow and develop, they produce a continuous mat on the soil surface. Some plants included in this group form roots along the stems, which serve to hold the plants tightly on the soil surface and also hold the soil in place. Other types spread by procumbent trailing stems and often create a wavy appearance and do not form roots unless they are induced artificially. The depth to which the roots penetrate the soil and the manner in which they are formed determine their value as soil binding plants to prevent erosion.

The use of ground cover plants to carpet the soil in compact continuous mats provides an ideal environment for the breakdown of organic matter.

The leaves, stems, flower pods, and seeds from most garden plants that collect on the ground are not returned to the soil as organic matter, but are more often raked up and removed from the garden to provide a neat appearance. In ground cover planting, all of this plant debris collects beneath these plants as it falls and the ground cover provides the proper environment for a complete breakdown and return to the soil.

In present day gardens, there is often more bare soil areas than are practical to maintain or that are pleasant to look at. Bare soil requires mulching or frequent weeding or other maintenance to keep it attractive. Soil supporting a green plant cover is protected from the hot, direct rays of the sun and thus is kept loose and can absorb moisture more readily. Ground covers also shade the soil and prevent excessive evaporation.

Not all plants classed as ground covers are suitable for all purposes or are of equal merit or value. All plants that can be included in this group must be carefully evaluated for specific uses in any landscaped area, not only for over-all effect and permanence but as to growth habit, soil requirements, and textural qualities as well.

The selection of ground cover plants for landscape use is much the same as the selection of any other landscape plant in any approach to easier gardening. This is the selection of the right plant for the right place. Ground cover plant lists include woody vines, dwarf shrubs,

sub-shrubs, some plants usually associated with rock gardens, and other herbaceous perennials. Ground cover plants also include miniature plant types which cling to the soil and grow less than one inch in height for use between stepping stones, around patios and terraces as a substitute for grass to cover the soil and soften the appearance of paved areas.

Landscape Uses of Ground Covers

Ground covers are used to satisfy many practical requirements in any landscaped area as well as for their artistic value. They reduce the need for frequent irrigation, fertilization, and pest control. Since they are both woody and herbaceous perennials, they provide permanent objects.

There are types to use to solve almost any landscape problem area, including problems with various types of soil, flat surfaces and slopes, sunny or shady situations and the difficult places where grass or other plants do not fit, or are not well suited.

While grass may be conceded to be the finest of all ground covers there are places where grass does not grow readily or where it is impossible to maintain it properly. The time required to maintain a high grade lawn and the cost involved are often considerable. A good lawn requires continuous mowing, fertilizing, spraying and irrigation which results in a large expenditure of dollars and man-hours. In shady areas where grass is difficult to grow, more time and money is spent than the area is worth. From a purely practical standpoint, ground covers are often as effective as grass in the control of dust and mud near building entrances and in various other situations throughout the landscaped area.

The primary purpose of ground covers is to cover the bare soil in all parts of a landscaped area. When the soil is not covered with turf, exposed ground needs to be planted in some manner if only to keep it from being infested or overrun with weeds. Ground covers are very adaptable and can fulfill a variety of related needs in any landscaped area and their practical value is easily recognized.

Some of the more prominent uses of ground covers in typical situations are the following:

1. Shady areas under trees and shrubs.
   Plants that form a dense mat are used as a carpet to cover the soil. Taller sorts can also be used to provide a pleasant setting for the trees and shrubs.

2. Underplanting trees and shrubs to reduce weed control problems.
   The soil areas beneath high branching plants can become a high maintenance cost nuisance to keep attractive unless suitable cover is provided.

3. Concealing exposed tree roots.
   When large trees adjoin or are a part of a lawn area development, they often develop exposed roots. This problem plagues gardeners since grass is neither easy to mow or easy to maintain and exposed roots are a hazard. Ground cover plantings solve both problems.

4. Covering banks & slopes.
   Turf cover is usually not satisfactory for banks or slopes

especially from the standpoint of satisfactory maintenance. Erosion is also a problem, both in sunny and shady exposures. Steep grades usually require deep-rooted, low-growing plants to hold the soil and to better organize the entire planting scheme.

5. Binders for sandy soils.
Ground covers are invaluable for holding sandy soils in place in inland plantings, but those that are tolerant of salt spray are especially adptable for holding sandy soils in seaside areas.

6. Cover for uneven rocky land.
Outcroppings of rock or other rocky uneven areas can become distinctive landscape features when suitably planted with ground covers, crevice, and rock plants.

7. Providing a setting for bulbous plants.
The contrasting foliage of ground cover plants provides a setting, and in addition, acts as a foil for flowering bulbs. Bed maintenance is also reduced and many bulbs such as lilies, require shade over their roots.

8. Reducing weeds among perennial plantings.
The practice of using ground cover plants to interplant large-scale herbaceous perennials has proven to be a very satisfactory landscape procedure, especially in planting of daylilies, iris, chrysanthemums and hardy asters.

9. Solving wet-soil problems.
Some ground cover plants prefer moist heavy soil. Others are creeping plants native to boggy conditions where they thrive on hummocks of soil.

Ground covers are available in a wide diversity of form, and when used properly they lend a finished appearance to shrub and flower bed plantings and in many cases eliminate the necessity of maintaining sharp edges between beds and turf areas.

They have unequalled value for year round color and interest and become eye catchers in plantings that are viewed from windows, entrances, driveways, and roads. They are also adaptable for planting strips along walks, small areas adjacent to buildings and approach areas.

Settings for garden ornaments such as pools, figures and benches can usually be softened and appreciably improved through the use of low ground covers.

These plants can be used effectively to soften the edges of steps and paths, and very often grade changes are a challenge that can be satisfactorily solved through the use of ground cover plants.

SELECTED LISTS OF COMMON GROUND COVER PLANTS FOR TEXAS

I. Ground Covers for Shady Situations

1. Carolina jessamine — *Gelsemium sempervirens*

2.	Coral Bells	Heuchera sanguinea
3.	English Ivy	Hedera helix
4.	Hall's Honeysuckle	Lonicera japonica halliana
5.	Lily-Turf	Liriope muscari
6.	Perivinkle	Vinca major
7.	Starjasmine	Trachelospermum jasminoides
8.	Sand Strawberry	Fragaria chiloensis
9.	Virginia Creeper	Parthenocissus quinquefolia
10.	Wintercreeper	Euonymus fortunei radicans

II. Ground Covers for Hot, Dry Exposures and Sandy Soils

1.	Beach Wormwood	Artemisia stelleriana
2.	Blue Fesque	Festuca ovina glauca
3.	Broom	Cytisus procumbens
4.	Dwarf Rosemary	Rosmarinus officinalis prostratus
5.	Fleeceflower	Polyganum reynoutria
6.	Hall's Honeysuckle	Lonicera japonica halliana
7.	Lantana	Lantana sellowiana
8.	Lavendercotton	Santolina chamaecyparissus
9.	Mat Grass	Lippia canescens
10.	Moonseed	Menispermum canadense

III. Ground Covers for Moist Soil

1.	Coral Bells	Heuchera sanquinea
2.	Daylily	Hemerocallis hybrids
3.	Dichondra	Dichondra carolinensis
4.	Fleeceflower	Polyganum reynoutria
5.	Foam Flower	Tiarella cordifolia
6.	Forget-Me-Not	Myosotis scorpoides
7.	Goutweed	Aegopodium podogaria variegatum
8.	Moneywort	Lysimachia nummularia
9.	Sweet Woodruff	Asperula odorata
10.	Sweet Fern	Comptonia peregrina

IV. Ground Covers for Seaside Plantings

1.	Beach Wormwood	Artemisia stelleriana
2.	Blue Fesque	Festuca ovina glauca
3.	Creeping Baby's Breath	Gypsophila repens
4.	English Lanvender	Lanandula officinalis
5.	Evergreen Candytuft	Iberis sempervirens
6.	Fragrant Sumac	Rhus aromatica
7.	Japanese Juniper	Juniperus procumbens
8.	Memorial Rose	Rosa wichuraiana
9.	Roman Wormwood	Artemisia pontica
10.	Wire Plant	Muehlenbeckia complexa

V. Ground Covers with Distinctive Foliage Gray or Silver

1.	Beach Wormwood	Artemisia stelleriana
2.	Bloodroot	Sanquinaria canadensis
3.	Blue Fesque	Festuca ovina glauca
4.	English Lavender	Lavandula officinalis
5.	Fig-Marigold	Mezembryanthemum species
6.	Gold Dust	Allyssum saxatile
7.	Lamb's Ears	Stachys lanata

8.	Lavendercotton	Santolina chamaecyparissus
9.	Pussytoes	Antennaria rosea
10.	Sun-Rose	Helianthemum nummularium
11.	Wooly Thyme	Thymus lanicaulis

Variegated Foliage

1.	Bigleaf Periwinkle	Vinca major variegated
2.	Bugleweed	Ajuga multicolor
3.	Dead Nettle	Lamium maculatum
4.	English Ivy	Hedera helix Stardust
5.	Goutweed	Aegopodium podograria variegated
6.	Lily-Turf	Liriope spicata variegated
7.	Plantain Lily	Hosta undulata
8.	Wintercreeper	Euonymus fortunei gracilis

Aromatic Foliage

1.	Bayberry	Myrica pennsylvanica
2.	Camomile	Anthemis nobilis
3.	Creeping Mint	Mentha requieni
4.	Dwarf Rosemary	Rosmarinus officinalis prostrata
5.	English Lavender	Lavandula officinalis
6.	Fragrant Sumac	Rhus aromatica
7.	Lavendercotton	Santolina chamaecyparissus
8.	Thyme	Thymus serphyllum

VI. Ground Covers for Frost-Free Areas

1.	Algerian Ivy	Hedera canariensis
2.	Asparagus fern	Asparagus plumosus
3.	Asystacia	Asystacia coramandeliana
4.	Baby's Tears	Helxine solerieroli
5.	Bracketplant	Cholorophytum elatum
6.	Bugleweed	Ajuga reptans
7.	Carolina jessamine	Gelsemium sempervirens
8.	Gazania	Gazania splendens
9.	Hemigraphis	Hemigraphis coloratus
10.	Orange clockvine	Thunbergia gibsoni
11.	Pinkhead Knotweed	Polyganum capitatum
12.	Tworow sedum	Sedum spurium
13.	Wandering Jew	Zebrina pendula
14.	White Stonecrop	Sedum album

VII. Annuals for Temporary Ground Covers or Living Mulches

1.	Alyssum Carpet of Snow	Lobularia maratima Carpet of Snow
2.	Cascade Petunia	Petunia hybrida White Cascade
3.	Creeping Zinnia	Sanvitalia procumbens
4.	Moss Rose	Portulaca grandiflora
5.	Persian Carpet	Alternanthera amoena
6.	Pinks	Dianthus barbatus Bravo
7.	Snapdragon, Floral Carpet	Antirrhinum majus Floral Carpet
8.	Trailing Lobelia	Lobelia erinus Trailing Sapphire
9.	Verbena	Verbena hybrida
10.	Vinca Rose Carpet	Lochnera rosea Rose Carpet

VIII. Evergreen Ground Covers

1.	Bigleaf Periwinkle	*Vinca major*
2.	Blue Rug Juniper	*Juniperus horizontalis wiltoni*
3.	Chinese Starjasmine	*Trachelospermum jasminoides*
4.	Coral Bells	*Heuchera sanguinea*
5.	Creeping Lilyturf	*Liriope spicata*
6.	English Ivy	*Hedera helix*
7.	Evergreen Candytuft	*Iberis sempervirens*
8.	Goldmoss Stonecrop	*Sedum acre*
9.	Hall's Honeysuckle	*Lonicera japonica halliana*
10.	Japanese Starjasmine	*Trachelospermum asiaticum*
11.	Lavender-cotton	*Santolina chamaecyparissus*
12.	Mother of Thyme	*Thymus serpyllum*
13.	Purple Japanese Honeysuckle	*Lonicera japonica chinensis*
14.	Sargent Juniper	*Juniperus chinensis sargenti*
15.	Shore Juniper	*Juniperus conferta*
16.	Tamarix Juniper	*Juniperus sabina Tamarix*
17.	Wintercreeper	*Euonymus fortunei radicans*
18.	Yellownet Honeysuckle	*Lonicera japonica aureo-reticulata*

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WATER QUALITY AND SALT PROBLEMS

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The quality of water for irrigation purposes is determined by the kind and amounts of various salts dissolved in that water. The very best water would contain no dissolved salts at all and would be the same as distilled water or similar to rain water. As rain water enters and percolates through the soil and the various gravel, sand and rock layers beneath the soil, it will dissolve any soluble salt that may be present.

We should, at this point, distinguish between a solution and a suspension. As water moves over or through a soil, it picks up silt and clay which will be held in the water by suspension but on standing may settle out. This material therefore is not a solution but is only physically carried along with the water.

Soluble salts, however, break down to form charged particles or ions when they are dissolved in water and will not settle out. They remain in solution and migrate or travel with the movement of the water.

The soluble salts that are most likely to be found in natural waters are listed as follows:

Cations (Positive ions)	Anions (Negative ions)
Na^+ Sodium	Cl^- Chloride
Ca^{++} Calcium	$SO_4^{=}$ Sulfate
Mg^{++} Magnesium	HCO_3^- Bicarbonate

There are usually small amounts of various other inorganic salts present.

Effects of dissolved salts on plant growth.

Dissolved salts tend to be more injurious as their concentration or amount increases. However, not all salts have the same degree of toxicity or injurious effects on plants at any given concentration. Also, crops vary considerably in their sensitivity to saline water.

The two most injurious elements in natrual irrigation waters are usually sodium and boron. Salinity effects can be divided into two categories.

A. Injury to plants

All salts are injurious to plants but sodium and boron are especially serious. Boron is particularly toxic to grasses which cannot tolerate over about 0.3 parts per million of this element. This would be equivalent to about 8 pounds of borax per acre foot of water.

Salts in water affect plant growth in several ways but one of the most important is the reduction of the availability of water to the plant. As the salt content increases, the plant takes up less water through its roots. At very high salt concentrations, plants can actually wilt from a shortage of water with its roots growing in moist soil.

This salinity effect due to concentrations of soluble salts can be estimated by measuring the conductivity or the ability of a solution to carry an electric current which is directly related to the concentration of salts in the solution.

Scale for Classification of Irrigation Waters

Conductivity (Micromhos per centimeter)	Class of Water	Salinity Hazard
100 to 250	1	Low
250 to 750	2	Medium
750 to 2250	3	High
2250 to 5000	4	Very High

b. Effect of dissolved salts on soils

The two elements, sodium and calcium are much more important in their effects on soil than are the other elements.

Calcium tends to bind soil clay particles together into crumbs or aggregates that makes the soil more porous and open and allows better penetration of air, water and roots. Therefore, an excess of calcium is beneficial to soil structure.

On the other hand, sodium disperses the soil clay particles so that no aggregation is possible and a very tight soil results with little open space for the penetration of water, air and roots. Thus, in rating an irrigation water, in addition to the amount of total soluble salts and their effects on plants, we look for the amounts of calcium and sodium and their effects on soil.

Magnesium is included with calcium and a ration of $\frac{\text{Magnesium} + \text{Calcium}}{\text{Sodium}}$ is calculated which is called Sodium Adsorption Ratio or SAR which rates the sodium hazard of the irrigation water. The SAR values are different for each different total salt content of the irrigation and results in a rather complicated rating diagram.

Thus, in rating irrigation water, three important points are taken into consideration.

1. The salinity or total salt content.
2. The sodium hazard or balance of calcium, magnesium and sodium.
3. The boron content.

GOLF COURSE MANAGEMENT

Carroll F. Kiser, Superintendent
Midland Country Club
Midland, Texas

JOB RELATIONS: A SUPERVISOR GETS RESULTS THROUGH PEOPLE

Foundation for Good Relations

Let each worker know how he is getting along.
- Figure out what you expect of him.
- Point out ways to improve.

Give credit when due.
- Look for extra or unusual performance.
- Tell him while "it's hot".

Tell people in advance about changes that will affect them.
- Tell them WHY if possible.
- Get them to accept the change.

Make best use of each person's ability.
- Look for ability not now being used.
- Never stand in a man's way.

People must be treated as individuals.

HOW TO HANDLE A PROBLEM: DETERMINE OBJECTIVE

1. Get the Facts
   - Review the record.
   - Find out what rules and plant customs apply.
   - Talk with individuals concerned.
   - Get opinions and feelings.

BE SURE YOU HAVE THE WHOLE STORY

2. Weigh and Decide
   - Fit the facts together.
   - Consider their bearing on each other.
   - Check practices and policies.
   - What possible actions are there?
   - Consider effect on individual, group, and production.

DON'T JUMP TO CONCLUSIONS.

3. Take action.
   - Are you going to handle this yourself?
   - Do you need help in handling?
   - Should you refer this to your supervisor?
   - Watch the timing of your action.

DON'T PASS THE BUCK

4. Check Results
   - How soon will you follow up?
   - How often will you need to check?
   - Watch for change in output, attitudes, and relationships.

DID YOUR ACTION HELP PRODUCTION?

"North Carolina State Department of Public Instruction"
Milwaukee Sewage Commission

IRRIGATION: HOW AND WHEN TO WATER

Joe A. Smith
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Dallas, Texas

Water content exerts a profound influence upon the form, structure and growth of a plant. Water is important to the plant in many ways. It is a component of protoplasm and with carbon dioxide is essential in building plant foods. It usually constitutes 70 to 90% of the weight of plants. All substances that enter plant cells must do so in solution. Water is a great solvent. It serves as a medium of transportation of nutrients from place to place within the plant, acting as a buffer in absorbing the heat is utilized in changing liquid water to vapor during the transpiration process. Shortage of water results in retarded growth and general weakness which makes the plant vulnerable to disease, insect and mechanical damage.

One way to approach the subject of "How and When to Water" is to take a close look at the soil which is the resevoir that the plant draws on. Most golf courses try to improve on natures work and construct their own soil. They do this for various reasons, mainly to form a soil which will resist compaction, promote extensive and deep roots and last but not least, one which will absorb and hold sufficient amounts of nutrients, air and water. Since we are dealing with the subject of water let us consider what are the determining factors for water retention in a soil. Most important are soil texture or size of particles, soil structure, i.e., the arrangement and compactness of the particles, and the amount of organic matter and collidal clay. Since water is held as thin films upon the surface of soil particles, the amount held in a soil will depend on the amount and size of the particles. Dry sands, (large particles) absorb and retain about .5 inch of water per foot of soil depth, while a dry clay loam (fine particles) will have the capacity of 2 to 2.5 inches. Sandy soil mixtures are droughty and must be watered more frequently than heavier soils with more particle surface area to retain more water. Organic material content of a soil also affects the watering schedule. Organic material retains large amounts of water on the extensive surfaces of its colloidal constituents and holding it like a sponge in its less decayed portions. It also has an indirect effect through soil structure. Sand particles are loosely cemented together by it, hence, percolation is decreased and water retaining capacity of the sand increased. Minute clay particles are enclosed in aggregates by the colloidal film of humus. This results in increased percolation and a decrease in soil surface exposed for retention of water.

When constructing or making a soil for a green, tee or fairway keep these factors in mind. Too little water and too much water both produce undesirable effects. Combine the soil constituents in amounts which will produce adequate water absorption, sufficient water holding capacity and good internal drainage to allow for excess water sometimes received through heavy rainfall or a mistake in irrigation.

Now that we have generally reviewed why the plant needs water and the important part soil will play in supplying it, let us turn to a few comments on how roots react to moisture and how water or moisture reacts in the soil.

Plant roots will not grow in dry soil. Water from rain or irrigation that fails to moisten the full depth of dry soil will encourage shallow rooting. If only the upper part of root zone is wetted, losses by evaporation are increased and plant growth retarded more quickly than if the entire zone is moistened. It is, therefore, highly desirable to moisten the entire root zone without excessive saturation. Too much water will fill up spaces in the soil needed for oxygen storage, which is also essential for plant growth.

Water moving into dry soil forms a distincy wetting front. Dry soil is slower to wet than moist soil and the wetting front is sharper in drier soils. Consequently, when a limited amount of water is applied the water will be distributed unevenly. The surface soil becomes moist, but the lower soil remains dry. Movement of water from the wet area to dry is very slow and can only be speeded up by applying more water.

Roots absorb water freely when a soil is adequately moistened. The work required by the roots to remove water becomes progressively greater as the soil moisture is reduced. When a point is reached where a large change in work is required to remove only small amounts of water, the plant will soon suffer. Wilt is one of the first signs which indicates that this point is being reached. Water should be supplied before this point is reached by most of the soil in the root zone.

When supplying water - do it at the rate which the particular soil can absorb. Applying water too fast results in flooding, run off and erosion. The percipitation rate of the sprinkler irrigation system should never be greater than 80% of the absorption rate of the soil layer within the root zone. For example, if the soil can absorb .3 inch per hour, the sprinkler system should be designed to apply not more than .24 inches per hour. Soil conditions will vary and the precipitation rate of a given sprinkler system pattern will vary. For best results the timing of how and when to water should be based on the heaviest soil condition and highest percipitation rate of the sprinkler system pattern.

Temperature naturally has a great influence on watering schedules. During hot, dry periods the transportation rate of the plant is greater and therefore the plants draw moisture from the soil at a faster rate. High winds have a drying effect. Here again we have a yardstick to use in setting up a watering schedule. If we know a particular soil holds 1" of water when the entire root zone is moist and the turf transpires a quarter inch per day under specific conditions, the moisture level can be maintained by applying 1/2" every third day, or 3/4" every third day. Under certain climatic conditions, it may be best to apply 1/4" every day. This holds true on bent grasses in this region during the hot, dry summer. Keep in mind that water also acts as a buffer, so make sure there is adequate moisture available during freezing temperatures. Winter kill will be greatly reduced.

One aspect in irrigation is often overlooked or forgotten when laying out a watering program and that is the effect of fertility. Unless enough nutrients are available to the plant to produce maximum growth at all times, nothing will be gained by keeping moisture available at high levels. Water alone will not produce growth.

One fallacy is the belief that by keeping the plant suffering for water will force the roots downward into deep soil. Plant roots grow deeper in soils that are kept moist but not wet. Remember that the growth of roots is reduced during any period when moisture is deficient in that portion of the soil already occupied by roots.

In summary we can make the general statements on How and When to Water:

1. Apply water at a rate which allows deep penetration without run off or standing water.
2. Apply enough water to wet the entire root zone. Do not shallow water.
3. Keep a check on you soil and familarize yourself with its moisture retention ability.
4. Set up your water schedule by taking into account the time of the year, the soil and the growth of the plant.

PROGRAM PLANNING AND HANDLING

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Planning defined - A scheme of action or procedure. A plan of operations.

Why Plan:

Efficiency of labor operations increases or decreases in a direct ratio with good planning. As labor will run from 60 to 85% of any total park or school budget, and with labor costs constantly increasing, we have to get maximum efficiency from our labor to survive.

Our own labor, percentagewise, runs as follows: Golf Course Division 64%; Recreation Division 80%; General Parks Division 62%; Percentage of total park system budget allocated to personal services is 67%.

An Outline of Planning Procedures and Techniques

I. Planning
   - A. Long Range
     1. Master Plan
     2. Annual Work Program
   - B. Immediate
     1. Monthly
     2. Weekly
     3. Daily

II. Planning Considerations
   - A. Objectives
     1. Long Range
     2. Immediate
   - B. Assest (In view of objectives)
     1. Equipment
        - a. General condition and state of maintenance
        - b. Adaptability of equipment to the specific job
          - (1) Do we have the right equipment?
          - (2) If not, is it better to:
            - (a) Buy it?
            - (b) Rent it?
            - (c) Contract the work?

     2. Personnel
        - a. Supervisory
          - (1) Foremen
          - (2) Subforemen or leadsmen
        - b. Labor
          - (1) Skilled
          - (2) Semi-skilled
          - (3) Common
        - c. Maximum efficiency from personnel
          - (1) The individual

II. cont'd.

(a) Each man/woman is an individual
(b) Individual skills, abilities, and interests
(c) The right man for the right job
(d) In-service training
1. Care and maintenance of equipment
2. Operation of equipment
3. Job "know-how"
4. Safety
5. Work methods and techniques (the "easy" way and the "hard" way to do a job)
6. Importance of the individual
(e) Working conditions
(f) Morale

C. Liabilities
1. Lack of funds
a. Low wage scales for labor
b. Competition for labor with private enterprise
c. Limitations on equipment purchases and availability
2. Extraneous considerations
a. Weather
b. Emergencies
c. Importance of alternate plans

Outline for Immediate Labor Plans
(Section I-B of Master Outline)

I. Immediate Labor Plans
A. Monthly Plans
1. Monthly objectives outlined by supervisors
2. Foreman detail and present labor plans to supervisor for approval
3. Importance of delegation of authority
4. Monthly plans outlined by foremen to entire labor force
a. Importance of men being "in the know"
B. Weekly Plans
1. Objectives based on monthly plans and work progress
2. Clarification of objectives to each group and individual
C. Daily Plans
1. Clear objective on part of each individual as to work to be performed
2. Need for having <u>all</u> tools and <u>all</u> materials loaded on trucks for the job at hand
3. Planned truck routing to avoid unnecessary "backtracking" and excessive "riding" time
D. Alternative Plans
1. Inside work for extreme weather
2. Secondary work objectives in event type of weather makes primary assignment impractical
3. Secondary work objectives if unavoidable work stoppage occurs
4. Standing orders for <u>all</u> employers when work stoppage occurs
a. Above all <u>do something</u>
(1) Police area for trash, debris, broken glass etc.
(2) Close observation of immediate area and other areas passed enroute to assigned task

I. cont'd.

(a) Water running or leaks
(b) Vandalism
(c) Broken tree limbs
(d) Trash and debris

(3) Immediate remedial action if practicable
(4) Importance of reporting items to supervisors when remedial action not practical

WEED CONTROL IN TURFGRASS

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Control of weeds in turfgrass should begin with some basic understandings of the weeds:

Classification: By length of life

1. Annuals - has life cycle from seed in one year or less
   a. Summer Annuals: examples include crabgrass, foxtail, goose grass
   b. Winter Annuals: examples include Poa Annua, shepherds purse, henbit
2. Biennials: Plants life cycle more than one year but not longer than two years. Few troublesome weeds to turf in this group in our area.
3. Perennials: Plants life cycle more than two years, many would exist indefinitely if not controlled.
   a. Simple Perennials: Spread by seed -- examples include dandelions, curly leaf dock, plantains
   b. Creeping Perennials: Reproduce and spread by creeping roots, stolons and rhizomes. Examples include mouse ear chickweed, ground ivy, Dallisgrass, Johnsongrass and even Bermudagrass, if it is out of place.

Lets mention some methods of chemical control that we would be most concerned with:

1. Contact Herbicides: Kills portions of plant covered by chemical no translocation of this herbicide through living cell of plant. Action of material usually "quick" - effective for top knockdown or temporary control.
   a. May be either selective - kills or burns some species of plants while little or no injury to other species.
   b. or non-selective - toxic to all plants being treated.
2. Growth Regulators: Usually referred to in our sessions as
   a. translocated herbicides or
   b. systemic herbicides

   This group of herbicides may be taken into plants by leaves or roots and move through the plants system. Are slower in action than Contact Herbicides. This is the group of herbicides we do most of our spraying with. Correct application important here:
   a. An overdose may prevent these herbicides from doing their job just as much or possibly more than an underdoze.
   b. On perennial weeds where roots, stolons and rhizomes must be killed by leaf spraying. Low rates and repeat application may be desirable - especially on turf - for appearance.
   c. This group of herbicides usually selective - work on only certain species of plants (when used at proper application rates) makes possible to control certain undesirable plants without great damage to turf in most cases.
3. Soil sterilants: These herbicides actually prevent growth of

plants when they are present (at certain rates) in the soil.
Classified as:
a. No Residual toxicity: Sterilizes soil for less than 48 hours
b. Temporary Soil Steriliant: Sterilizes soil for 4 months or less
c. Semi-Permanent: 4 months to 2 years
d. Permanent Soil Steriliant: Sterilizes for more than 2 years

Other terms to become familiar with:
1. Preemerge Herbicide: This group of herbicides must be applied before any of the seed of the specie to be controlled has germiniated if good control is to be expected.
Apply in early spring for summer annuals.
Apply in early fall for winter annuals.
2. Postemerge Herbicide: This merely refers to any class of herbicides recommended for treatment after emergency of a plant.

Methods of Applications:
1. Broadcasting - uniform application on a given area
2. Spraying
3. Spot treatment - may be either spot broadcasting or spot spraying

Remember:
Caution all workers of dangers involved in handling of herbicides -- Preach -
Practice -
Perform - Safety with herbicides

Follow Directions:
Test all new herbicides on a plot before applying on large scale operation, then use the: Right Amount of the
Right Herbicide with the
Right Amount of Water on the
Right Area

Slides on weed identification and weed control work on land and water and equipment were shown.

TURFGRASS AND THE WEATHER

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The varying pattern of temperature, wind, rainfall and sunshine found in a given place over a period of years is called climate. The actual condition of the wind, rain, sunshine and temperature in any given place at any given time is weather. Climate is not the same as weather; it is the average of weather conditions.

Climate is important to turfgrass managers because it determines to a large extent the adaptability and suitability of a particular grass plant to a given set of turfgrass conditions. Further, knowledge and understanding of climate, and of seasonal averages or conditions, are necessary and basic to the development and execution of long-range planning. For example, if the policy of a golf club is to provide live green grass on all putting surfaces during the winter months, then the superintendent must plan to: 1) maintain bentgrass during summer and winter months; or 2) overseed bermuda with suitable cool-season grass. The climate prevailing in the given area will dictate which program to follow. The plans developed by the superintendent or turfgrass manager will be determined by his knowledge of certain climatic information, for example, the average date of the first killing frost. The actual execution of the program will be controlled by weather conditions -- a heavy, driving rainstorm would preclude fertilizing or other routine activity on the grounds

The components of weather are the same as those of climate -- wind, sunshine, rain and temperature. These factors affect the day-to-day health and vigor -- the physiological well-being -- of the plant. In addition, and perhaps most important, they affect the application and timing of practices concerned with growth activity and use of the turfgrass. These practices, generally called management practices, are fertilizing, watering, cultivation, mowing, and programs to control disease, insects and weeds. Much of the "art" of growing turfgrass is associated with an individual's ability to cope successfully with the intricacies of daily and weekly weather patterns.

The kind of recreational activity, or the use, for which the turfgrass area is maintained is affected by weather in different ways. During adverse weather, such as a heavy rainstorm, use or playing activity stops on a golf course and is curtailed on a park site or on a baseball field. However, on a football field the game is not called. Use or non-use during such periods of adversity substantially affect management practices and plans.

Disease and weed control programs are keyed to temperature and moisture. Weeds are generally controlled more easily if treated during periods of active growth. Activity of disease producing organisms is influenced by both temperature and moisture.

Weather and Growth Processes

Growth is a complicated summation of a number of essential processes, each of which is influenced in varying degrees by weather phenomena -- especially, in the case of turfgrass, temperature. Temperature effects on carbohydrate accumulation and movement, on the absorption of water and nutrients, and on root growth may serve to illustrate this relationship.

Carbohydrates required at the growing points must be translocated from storage tissue in the roots or shoots, or from leaves where they are produced by photosynthesis. The rate of photosynthesis is influenced to an extent by temperature: high temperatures favor more rapid translocation and accelerated respiratory activity; while low temperatures retard translocation and depress respiratory activity. Hence, low temperatures favor an accumulation of photosynthetic products (carbohydrates), while high ones may cause a serious depletion of carbohydrate materials and may, therefore, restrict growth.

Within limits, the rate at which water and nutrients are absorbed increases as temperatures rise and decreases as temperatures decline. The viscosity of water is twice as great at 32 degrees as at 77 degrees, and the viscosity of protoplasm is several times as great at 32 as at 77 degrees. An increase in the viscosity of water results in a slower movement from the soil to the root, as well as in the root. Likewise, an increase in the viscosity of protoplasm retards water movement within the root.

Temperature is one of the major factors which influence the rate of transpiration. The effect is direct; i.e., when temperatures increase, transpiration increases, and when temperatures decline, transpiration is reduced. Low soil temperatures reduce water absorption, while high atmospheric temperatures increase transpiration. Under such conditions, wilting becomes a possibility. Wilting always occurs whenever transpiration exceeds water absorption.

Root growth at various levels of oxygen is strongly influenced by temperature. It has been shown that at an oxygen concentration of three (3) percent and at temperatures of 64 and 86 degrees, root growth is inhibited; whereas, at an oxygen concentration of 10 percent, root growth is normal at 64 but reduced at 86 degrees. This indicates that at the higher temperature, 10 percent oxygen is deficient. Further work has shown that (1) at oxygen concentrations of less than one per cent, roots lose weight; (2) concentrations from 5 to 10 percent are necessary for the growth of existing root tips; and (3) oxygen concentrations greater than 12 percent are required for root initiation.

Within the temperature limits for root growth, the greater the temperature of the soil, the higher must be the concentration of oxygen in the soil atmosphere for normal root growth. Cannon attributes this relationship to decreasing solubility of oxygen in the soil solution with increased temperature. Although this may be a factor,

the effect of increasing temperature on respirational demands of the roots for oxygen certainly plays an important part.

The response of different grasses to temperature is more the function of climate than weather. Because both cool and warm-season grasses are adapted and used in Texas, a discussion may be in order. It appears that soil temperatures of approximately 59-60 degrees are optimum for growth of Kentucky bluegrass, and that temperatures above 80 degrees are unfavorable. Bermuda grass, on the other hand, continues to grow up to 100 degrees (the highest temperature studied.) So, it appears that maximum growth of Bermuda occurs at soil temperatures around 95 degrees.

The slowdown in growth of cool-season grasses may be a result of restricted carbohydrate supply to roots, rather than the high temperature. This could result from an increase in air temperature which causes a low rate of foliar growth. At least it has been indicated that high temperatures adversely affect ryegrass by causing a rapid dissipation of reserve carbohydrates and retarded production of new leaf growth.

Weather and Water Needs

Turfgrasses, like all plants, require very large quantities of water for all phases of their growth and activity. Water is necessary for germination, for cellular development, for tissue growth, for food manufacture (photosynthesis) and for temperature regulation. It acts as a solvent and carrier of plant food materials. The amount of water within the cells of the grass leaves plays a major role in counteracting the effects of traffic. Turgid leaves (cells filled with water) resist pressure or traffic; whereas, damage may result to grass leaves in a state of wilt or near wilt when they are subjected to only slight pressure (light traffic).

Evapotranspiration is the word coined to represent all water lost from plants through transpiration and by evaporation from soil and plant surfaces. The term "consumptive use" refers to loss during the growing season and is sometimes used synonymously with evaportranspiration.

Evaporation. Water will pass from the liquid to gaseous phase when it is heated. Heat speeds up the movement of water molecules. When a velocity sufficient to overcome the attractive forces of the liquid is attained, the molecule escapes to the atmosphere as water vapor -- a gas -- and that is called evaporation. The rapidity and amount of water evaporated from a given surface is a function of the amount of energy or heat applied, as well as, of course, the quantity of water available. Solar energy supplies the heat responsible for evaporation from plant and soil surfaces, accounting for a portion of the water lost from turfgrass areas and, often a substantial amount of loss from ponds and reservoirs.

Transpiration. Transpiration is the emission of water vapor from the leaves and stems of plants. This gas escapes to the atmosphere through the stomate -- pores or openings in the leaf. Water

is taken into the plant through its root system. A small portion is used for growth activity, the remainder (and by far the greater amount) passes through the plant system, out of the stomata and into the atmosphere. In this sense, the plant acts as a pumping system. Solar heat provides the "energy" that triggers or activates the system. Unfortunately, this power source cannot be turned off at will and, as a result, complications with the system (plants) often arise when high temperatures prevail. For transpiration will continue to increase with increasing radiation; whereas, the rate of photosynthesis will increase only to a certain point.

The water lost through evapotranspiration is significant because it approximates closely the total amount of water needed for plant growth. More importantly, quantitative values for ET may be calculated and formulas have been developed for this purpose.

A number of investigators, concerned with calculating theoretical and actual water needs, have shown that -- after adjusting for day length -- a close relationship between mean temperature and potential evapotranspiration exists.

The need to water is affected by the length of the growing season; the rate, amount and distribution of rainfall; the soil texture; soil moisture content; the kind of grass and evapotranspiration. The collective interaction of these and other factors determines the water deficit or the water surplus.

Turfgrass managers and irrigation specialists are concerned primarily with the water deficit -- the difference between the amount of water needed for satisfactory growth and what nature provides in the form of rainfall, dew and fog. The water deficit must be supplied by irrigation if growth and color are to be maintained.

The number of months in which there is insufficient water delivered by nature to sustain satisfactory turfgrass growth varies from three to four in the Northeast of the country to over eight months in the more arid Southwest. It is significant that the deficit months occur during the growing season -- the time when most turfgrass recreational sites receive maximum usage.

Methods of Minimizing or Modifying Effects of Weather

A discussion of turfgrass and weather would not be complete without at least mentioning some of the techniques used by turfgrass managers to modify or compensate for weather adversity. One of the more important techniques available for reducing or lowering temperature is sprinkler irrigation. For example, in Arizona it has been shown that soil temperature following irrigation was lowered 4 to 10 degrees at a one-inch depth and 1 to 4 degrees at 3 inches. In Michigan, midday sprinkling during moderately arid conditions lowered the temperature 18 degrees in a tomato field, 12 inches above the surface and 22 degrees at the surface of muck soil. Purdue has reported a 17-degree drop in temperature as a result of syringing a golf green.

Frost control and other techniques of frost prevention were discussed by the author at this conference two years ago. These included the use of various covers and mulches, as well as soil warming. Other factors that affect temperature changes and which are significant from the standpoint of turfgrass management would include:

1. Shade -- Cooler temperatures under shade trees scarcely require mention. Brown (Missouri), in a study comparing summer temperatures at a depth of one-half inch under a bare soil and a Kentucky bluegrass sod, found that the semi-monthly mean values of the daily maxima were as much as 10 degrees higher and minima were as much as 5 degrees lower for the bare soil than for bluegrass sod. Similar effects (though probably not as great) would be expected under thin stands in contrast to dense stands of turf.
2. Mulch -- An organic mulch will absorb heat and insulate the soil.
3. Dark materials absorb heat -- the use of dark, amorphous materials -- such as lamp black, sewage sludge and top-dressing -- to speed the melting of ice on greens takes advantage of the heat-absorbing properties of these materials. This is also one reason why bentgrass greens should not be topdressed during summer months.
4. Location and position -- When choosing a site, it is well to remember that, in general, southwest slopes are the warmest. Whenever possible, turf areas (such as greens) should be faced toward the sun (southward) in the colder climes and away from the sun (northward) in the warmer latitudes to take advantage of this difference in temperature. Other topographic features to keep in mind when selecting a site are: the fact that cool air settles in valleys during the night, and that high wind-swept hills are more subject to excessive transpiration. Exposure to wind and provisions for adequate air drainage are of importance from turfgrass management and temperature standpoints. Nearness to buildings likewise affects these factors because of the influence of radiant heat.

HERBICIDES TO KILL WEEDS

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The development of specialized agricultural chemicals in the last several years has been phenomenal to say the least. In fact, new chemicals for specialized uses in the parks and grounds maintenance area alone have been such that there are very few people in the field that have a working knowledge of the many chemicals available to aid in maintenance operations.

In so far as chemicals for weed control are concerned, I doubt that more than two or three of the more than forty herbicides available are used in any one maintenance operation represented her today. Even with all the potential savings herbicides offer, this is generally true of most operations. There is then the question of why we do not make more use of the many herbicides available.

First of all I think it may be because most of us lack the knowledge and understanding of herbicides that would permit us to trust our use of them. Secondly, we have heard from one source or another many tales of bad experiences in the use of herbicides, or more properly the misuse of herbicides, and tend to fear making such a mistake ourselves. Or thirdly, it may be because there are so many materials available and under so many brand names that we just cannot decide which material is the one best for the job we wish to accomplish. This being the case we continue with our present procedures and wait for that one simple "do-all" chemical that will solve all our weed problems.

Gentlemen, I doubt that that magic herbicide will be developed in the near future so our only course at present is to learn more about the materials that are available today and use them on a trial basis until we have the experience and knowledge to put them in general use in our respective operations. Most of us are like the old farmer that had to be "showed" that a tractor was better than his fine team of mules. We tend to doubt the value of a herbicide until we have been "showed" that it works the way that smooth talking chemical salesman says it will.

Actually, I believe most of us know and realize that chemicals are or can be a big help to us in maintenance operations. They can save many man hours of costly labor and contribute a lot to the appearance of our parks and campuses if we use them and use them properly. We also know that there are many things we can do to eliminate weed control problems through proper design of our facilities and especially through proper management of our turf and landscape plantings. It is wonderful to have good herbicides to use but it should always be our first goal to avoid the need for the use of chemicals at all in so far as it is possible to do so.

In designing our facilities there are several features that not only omit weed control problem areas but aid the overall beauty of the landscape.

Examples of these features would be concrete strips under fences, curbs around planting beds, edging strips at the base of retaining walls and buildings, paved areas under play equipment and picnic tables and other similar design details. These permanent features are costly to construct but they return the investment many times over in saved man-hours and improved appearance over a period of years. Most of these features can be off season foul weather projects and now is a good time to review these needs and schedule work for the winter months ahead.

Now is also a good time to review our management during this past maintenance season. Weeds seldom become a problem on properly managed turf, so when grass thins out and weeds invaid turf grass areas, we should carefully analyze the management practices being followed and see if there is anything that is being done improperly. There are many chemicals available for eradicating weeds in lawns and most are quite effective if applied at the proper time and in the proper manner. However, without correcting the basic or fundamental reason for weed invasion in the first place weed control chemicals are of little value to the turf grower.

Eradication of weeds in turf areas by means of chemicals should be followed by aerification and fertilization along with any alteration of watering and mowing practices that may be causing weed invasion. Through examination of all these practices we will often find the reason why the area became infested with weeds.

In so far as management around ornamental plantings is concerned, particularly in ground cover plantings, maintenance such as deep cultivation and heavy pruning should be accomplished well before the spring weed growth begins. This will allow root system recovery, insure vigorously growing plants and permit a complete cover of the ground before weeds can invaid.

If new plantings are installed it is always advisable to sterilize bed areas before planting. It may also be worthwhile to close plant spacings somewhat and get a quick cover of the soil. On this possibility the increased installation cost must be compared with the cost of weeding to determine which course to take.

Around all ornamentals, the value of soil mulches in weed control should not be overlooked. Mulches should be used at a minimum depth of two-three inches and should be in place before the growing season begins. Mulches of course also have an additional value in conserving soil moisture.

After proper design and proper management have been achieved, there are of course still many weed problems to contend with and this is where a herbicide program can be of value!

In setting up a program there are several considerations that will prove valuable.

1. Assign the responsibility for the program to one well trained, knowledgeable person and insist that he keep current on all new materials and methods of application.
2. Develop a scheduled plan covering the entire operation and

evaluate the results regularly.

3. Provide close supervision of all applications and properly train all workers assisting with the program.

4. Set up safety regulations and maintain a set of records that reflect the date, location, material use, and the weather conditions at the time of application.

5. Use new materials on a limited trial basis until they have been proven of value to the operation.

If these five guidelines are followed in setting up a program, good results will be obtained and problems if any will be small.

The attached chart lists some of the herbicides that may be of value to your weed control program.

Many new weed control materials and methods are presently under development and their release can be expected in the near future as research and testing are completed. A few of these materials and methods are as follows:

1. Eptam Concentrate: The evaluation of this chemical for spray application to lawns as well as around ornamental plantings is being studied as a control for nutgrass and other weeds. Tests to date show much promise and release for general use is expected soon.

2. Herbicide-Mulch: Tests by the University of Delaware show that the application of a herbicide and mulch in one easy step may be possible in the future. This idea could aid weed control around ornamental plantings where spraying is sometimes hazardous.

3. Herbicide Treated Cloth Net: A loosely-woven cloth treated with an effective weed killer has been tested as a safe and easy way to apply herbicides. Fourteen different herbicides were tried in the test with good results. The cloth is cut to fit the area then covered with a thin layer of soil to hold it in place. This material may be on the market in the near future.

4. Crabgrass Root-growth Inhibitor: A recent release from DuPont called Siduron is said to control crabgrass and at the same time permits turf grass seed to germinate and grow. The value lies in the fact that turfgrass seed can be applied at the same time a crabgrass control is on the ground. Consult DuPont on this one. Another similar chemical is Azak although less research information is available on this compound.

HERBICIDES FOR WEED CONTROL

NOTE: Consult container directions and rates for your particular application situation.

PROPOSED USE	HERBICIDE	SPRAY SOLUTION RATE-VOLUME	TIME TO APPLY	REMARKS
I. TURF WEED CONTROL:				
A. Dallis Grass in Bermuda	DSMA 20.5%	1 pint per 2-4 gal. water per 1000 sq. ft. plus wetting agent.	Spring when temp. is above 70 deg.	Avoid drift around ornamentals.
B. Dallis grass in St. Augustine grass (spot treatment	DSMA 20.5%	Same as above	Spring or early summer	Spray or mop onto individual plants. Caution: DSMA will also kill St. Augustine grass.
C. Crab grass in Bermuda	AMA	Follow mfg. recommendations	Spring or early summer	
	PMAS 10%	1 oz. PMAS per 1000 sq. ft.	Spring and summer	Also controls fungus diseases
	DSMA 20.5%	Same as Dallis grass rate above.	Spring and early summer	
D. Broad-leaved weeds in turf	2,4-D and Silvex	1/2 lb. of active ingredient per acre (consult directions on package)	Spring and summer	Use low pressure spray to avoid drift. Around ornamentals apply with sprinkler can. Wet foliage. Use wetting agent. Do Not exceed recommended rate on St. Augustine.
E. Preemergence crab grass control	Bandane 15% granular	0.81 lbs. of actual per 1000 sq. ft.	Early spring	Kills as seed germinate so apply early

PROPOSED USE	HERBICIDE	SPRAY SOLUTION RATE-VOLUME	TIME TO APPLY	REMARKS
II. Weed Control Around Ornamental Plantings and In Plant Beds				
A. Nut grass and most other weeds in and around established plantings.	Eptam 2.3 granular	Apply at rate of 1 lb. per 160 sq. ft. Cultivate into soil and water lightly.	Any time after growth starts in the spring or two weeks after transplanting.	Cultivate to remove existing weeds before application. Do not overdose. Consult directions as to use around specific plants. Repeat application as needed.
B. Soil Fumigants for pre-planting bed sterilization.	Dowfume MC-2	Use 2-4 lbs. of gas per 100 sq. ft. of bed.	Any time when temp. is above 70 degrees.	Apply under gas tarp. Use caution. This is a highly poisonous gas. Soil moisture must be present but not be too wet. Cultivate to depth penetration is desired. Wait 3-4 days before planting.
	Vapam or VPM	Use one qt. per 100 sq. ft.	Any time	Cultivate bed to depth desired. Apply material and water well to full depth. Puddle surface to seal in gas. Use bed in 3-4 weeks after aeriation.

	PROPOSED USE	HERBICIDE	SPRAY SOLUTION RATE-VOLUME	TIME TO APPLY	REMARKS
III.	Complete vegetation control Along Fences, Walls, Walk joints, Paved areas, Road shoulders, etc.	Chlorea granular	Apply 1-1 1/2 lbs. per 100 sq. ft. of area. Water in lightly. Do Not Permit Runoff.	Any time	Use light rates in areas close to ornamentals. Reapply as needed.
		Amate X 95%	Use 1-1 1/2 lbs. per gal. of water per 100 sq. ft. add Spreader-Sticker	Any time	At light rate can be used around trees and shrubs. Use 1 lb. per 2 gal. water
		"Telvar" W 80%	Use 3/4 lb. per 1000 sq. ft. area.	Any time	Complete vegetation control for log periods.
		Ureabor	Apply 1-2 lbs. per 100 sq. ft.	Any time	Complete vegetation control
		Sodium Chlorate	As per mfg. recommended rate for situation considered	Any time	Do not use near buildings and use with caution as is hazardous from fire standpoint. Good cheap vegetation control.
IV.	Under Brush Control	Amate X	1-1 1/2 lbs. per gal. of water.	During Growing Season	Wet foliage of undesirable plants.
		2,4,5-T Low-volatile ester	Follow mfg. rates of application	During Growing Season	Wet foliage of undesirable plants. Avoid desirable plants and use low pressure spray.

PROPOSED USE	HERBICIDE	SPRAY SOLUTION RATE-VOLUME	TIME TO APPLY	REMARKS
V. Aquatic Weed Control	Kuron	1 1/4 gal. acre ft. water	Spring and summer	Will control most pond vegetables.
	Kurosal G	25 lb. per acre ft. water	Spring and summer	Will control submerged vegetation.
	Aquathol Plus	Follow mfg. recommended rates	After water temperature reaches 65 degrees	Will control a wide spectrum of aquatic weeds. Will not kill fish.

HERBICIDES TO KILL WEEDS

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Managers of bermuda turf are interested in obtaining the greatest amount of weed control per dollar spent, regardless of the method of control used. Weed problems in bermuda turf change with the nature and intensity of site management. The major problem areas include the intensively managed greens, extensive areas of less intensively managed fairways, general maintenance of grounds and around clubhouses, and specialized areas such as sand traps. Each of these areas has individual weed control requirements based on level of maintenance, kind of turf and other desirable plants, weeds to be controlled, and the use which is made of the area.

To cope with this wide array of weed problems the manager needs a knowledge of contact, systemic and soil sterilant herbicides. Contact herbicides kill only the plant tissues to which they are applied, while systemic materials are absorbed into the plant and moved through the conducting tissues to the site of action. Soil sterilants are used to keep the soil bare of all live plants.

Contact and systemic materials may be either selective or non-selective. A selective herbicide kills or stunts weedy plants with little or no injury to associate desirable plants. Selective action can be achieved by considering plant age and condition, the nature of the herbicide, and the manner in which the application is made. The plant characteristics which influence susceptibility to a particular herbicide include the location of the growing points, external foliage characteristics, and physiological state.

Contact herbicides usually are effective against seedling plants having exposed growing points, but older plants with waxy coatings may not be wet sufficiently by water sprays of contact herbicides to provide a good kill.

Systemic materials must be intercepted by an abosorbing surface of the plant; be passed through the roots, stems or leaves into the conducting tissues; and moved within the plant to the site of action. A breakdown in any one of these steps will make the applied material ineffective. Some herbicides are converted from an inactive to an active form by the plant, while other materials can be detoxified by the plant. Susceptibility to a herbicide may be general, as shown by the selective control of broadleaf plants in grass with 2,4-D. On the other hand, many of the improved varieties of bermuda are more sensitive than common bermuda to a number of herbicidal materials. Age of plant and vigor of growth are important securing effective action with systemic materials.

Although certain similarities in chemical structures can be shown among many herbicides, slight differences may change the selectivity or make the materials inactive. Herbicides which are fat soluble, or which are applied as oil sprays or as emulsions, penetrate waxy coatings very

well. Generally, the same materials are less selective in this form than when they are applied as water sprays. Amine formulations of growth regulators which are applied as water sprays usually are less volatile than the same material as an ester formulation. Materials such as the triazines and substituted ureas are not readily absorbed by plant leaves, and they depend largely on root uptake.

Herbicides may be applied as liquid sprays or as granules, and some materials are available in both forms. Regardless of the form used, precision of application is extremely important in obtaining satisfactory results. Some materials may be applied as directed sprays to control individual plants or to specific soil areas for edging.

Pre-emergence materials such as simazine, trifluralin and DMPA are applied prior to the emergence of the weed, but they should not be used with overseeding. Post-emergence treatments such as 2,4-D are applied to emerged weeds.

Water quality may be important with some materials. A high sodium or carbonate content reduced the phytotoxicity of some aromatic herbicides. An intermediate ratio of sodium to calcium and magnesium increased the activity of DSMA (Santelmann, 1966).

A review of the herbicides presently in general use reveals that a large number of these materials may be useful in the management of various segments of bermuda turf. Recommended treatments are available from research (Trew, 1960; Trew and Long, 1959; Texas Agricultural Experiment Station Bulletin B-1029), and suggested treatments which may be applicable have been assembled from other sources. These suggested treatments should be considered on a trail basis until their performance can be tested locally. Rates for all treatments are on the basis of active ingredient per acre unless otherwise stated.

Broadleaf weeds in established bermuda turf

Both contact and systemic materials are recommended for post-emergence application during the winter when bermuda is dormant. Treatments with contact materials include endothal, 1½-2 lbs for henbit, clovers and other winter weeds; and paraquat, 1-2 lbs or ammonium nitrate, 1 lb/gal of water applied to 250 sq ft for most annual weeds. Treatments using the systemic materials, 1 lb of 2,4-D amine or 1-2 lbs of dicamba, for controlling a wide spectrum of broad leaf weeds should be applied when temperatures are above 50°F.

During the spring and summer growing season naptha can be used as a contact herbicide, usually as a spot treatment. Systemic herbicides which can be used at this time include ½-1 lb of 2,4-D amine or silvex, 1-1½ lb of dicamba or a combination of 1 lb of 2,4-D amine and ¼ lb of dicamba. Surfactant should be added to the spray mixture containing a systemic herbicide. Use a method of application which will not permit drift of spray particles containing systemic herbicides to other plants. Dicamba also is absorbed readily by

plant roots, so it should not be applied adjacent to shrubs or trees.

Treatments not yet recommended for broadleaf weeds include 1-2 lbs of 2,4,5-T or up to 2 lbs of 2,4-D. Wild garlic may respond to 2 lbs of dicamba, 2,4-D amine or 2,3,6-TBA; 1-2 lbs of paraquate; or 4 lbs of silvex. The selected herbicide should be applied initially during the dormant season and repeated as needed.

Weedy grasses in established bermuda turf

Pre-emergence as well as post-emergence applications can be used, but pre-emergence materials should not be used during the dormant season if winter grasses are overseeded. Pre-emergence materials recommended for controlling crabgrass and goosegrass include 10 lbs of bandane, 10-20 lbs of betasan, 10 lbs of DCPA, or 20 lbs of DMPA. These materials, as well as 6 lbs of trifluralin, are suggested for pre-emergence treatment for Poa annua. Although simazine provided excellent weed control, bermudagrass has been injured by rates as low as 3 lbs (Duble, 1965).

Post-emergence treatments recommended for broadleaf weeds include the endothall, paraquat, ammonium nitrate and naptha materials listed earlier. The methyl arsonates, including AMA, CAMA, DSMA and MSMA, at 5-8 lbs are recommended for nutsedge, Dallisgrass, crabgrass and sandbur. Several applications may be necessary to control perennial plants. The arsonates induced a temporary discoloration of Tifgreen bermuda which persisted for 5-7 days (Duble, 1965).

Weed control in newly-sprigged areas

Pre-emergence herbicides are concentrated in the surface layer of soil where germinating weed seeds are most numerous. Sprig or stolons for establishing a new turf, such as a green, usually are not set very deep. This shallow depth of planting places a very narrow tolerance on the number of herbicides which can be applied for pre-emergence weed control.

There are no recommended pre-emergence treatments for newly-sprigged greens, but a thesis by Duble (1965) furnishes some suggestions for local testing. After 5 weeks areas receiving no weed control supported a 10% cover of Tifgreen or Texturf-10 bermuda, while areas treated with 20 lbs of DMPA granules or 30 lbs of bandane had an 80-90% cover. The same rate of DMPA applied as an emulsifiable concentrate severely damaged springs, as did dimazine at rates as low as 1 lb, and betasan at rates as low as 10 lbs. Trifluralin at 1½ lbs, dymid at 4 lbs, and 12 lbs of DCPA were moderately injurious. Stolons failed to root in areas treated with betasan or DMPA emulsifiable concentrate. Bandane was the only material which appeared safe to use in conjunction with stolonizing.

Maintenance of grounds near clubhouse

Generally, the same materials recommended for weed control in

established turf can be used for lawn maintenance. Application of growth-regulating materials such as 2,4-D and silvex should be done using a mop or sprinkling can to avoid pressurized sprays. Dicamba, picloram and other herbicides which are absorbed by plant roots should not be used where they can come in contact with roots of desirable trees and shrubs. Edging should be done with DSMA, paraquat, naptha, AMS or other non-selective contact materials.

Soil sterilization in sand traps

Several materials may have utility as soil sterilants in sand traps, based on results of work in other fields. The substituted ureas such as monuron or diuron, fenac, or bromocil at the rates recommended by the manufacturer should be considered where tree roots are not present to absorb the herbicide. Where trees are present simazine or trifluralin should perform well. When weeds begin to re-infest the traps, a second application of the same material should be made.

SUMMARY

Turf managers are interested in the greatest amount of weed control per dollar spent. While herbicides offer many possibilities as tools for weed control in turf, specialized knowledge of the herbicides and of their effects on turf, as well as on weeds, is needed to properly use them. The herbicide user should read the label, test a material locally when there is any question, apply the herbicide conscientiously, and consider any unusual growth conditions which may influence the action of a herbicide. Finally, herbicides are not a substitute for good management practices, but should supplement them.

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DISEASE, CLIMATE AND PROPER USE OF FUNGICIDES

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Thank you, Mr. Chairman.

Ladies and Gentlemen:

May I thank you for this most enjoyable privilege of sharing with you another outstanding Texas Turfgrass Conference. It is a real pleasure to be here in Texas -- and to pick up the kinds of new information that can be gleaned only through sharing views with professional turfmen such as you here today.

This topic, "Disease, Climate, and the Proper Use of Fungicides," is an interesting and challenging one. It speaks to some of the basic fundamentals of turf management, and I suspect that most of us like to review these fundamentals, now and then.

When I first saw this topic I was a bit stumped as to how to approach it. Then I remembered a story, told me several years back by a spritely teen-aged nephew. It concerns two microbes who were living the the lymph stream of a horse. One microbe, more adventuresome than the other, complained that the two of them were stale-mated --were just existing -- were "not getting anywhere". He suggested they expand their area of operations -- sally forth into the exciting world beyond. The other thought this was a great idea -- so they left the lymph stream of the horse and ventured forth into the horse's bloodstream. This naturally made the horse quite ill -- so its owner promptly called in a veterinarian. The vet, quickly diagnosing the situation, prescribed a massive injection of penicillin into the bloodstream of the horse. This immediately cured the horse -- but it accomplished this by killing both microbes. The moral of this story, of course, is -- Never change streams in the middle of a horse!

But beyond the moral, the story enables us to draw an interesting analogy. In this fascinating world of turf you have literally billions of fungus organisms, which would correspond to our two microbes. These fungi live at rest, or in a state of dormancy, in soil, mat and thatch, in a "climate" or environment corresponding to the lymph stream of the horse. We introduce a new element into the picture -- a stand of nice tender turfgrass, which corresponds to the bloodstream of the horse. The fungi, now venturing forth, just like the microbes, seek a home in the leaf blades, stems, roots and rhizomes of the grass -- in so doing they begin to draw their sustenance from the grass. This weakens it, and interferes with its normal growth and development processes, thus causing <u>disease</u> and some damage, or even death, to the find turfgrass.

What these fungi don't know is that this particular turf they're invading is under the professional maintenance of an outstanding Texas turf manager, who is keenly aware that parasitic turf fungi are <u>always</u>

present in his area and will attack his grass when climate and other conditions are just right. This turf manager will approach the problem of controlling these fungi, and saving his grass, in one of two ways. If he's a fairly astute professional manager, he'll be on the alert for the first sign of disease -- and when he sees it he'll react just like the owner of the horse -- by applying curative treatment -- in this case a good fungicide that will stop the fungal attack, save his grass, and kill the fungi. But if he's a really outstanding turf manager, like most of you here in Texas, he will have applied a fungicide well before the fungi attack his grass -- then, when they attack, they encounter a fungicide "climate" -- or environment -- which kills them before they ever have a chance to cause any visible turf damage. This would be roughly equivalent (to use the illustration of the horse again) to the owner of the horse having had him vaccinated well before the two microbes embarked upon their adventure. Then, when they ventured into the bloodstream of the horse, they'd have been killed at once by the vaccine already present before they could cause any detectable illness.

As you see, we're talking fundamentals here -- the basic factors that can cause turf disease -- and examining how to control these factors to avoid turf disease.

Plant pathologists point out three factors as being all-important in turf disease development. One of these, of course, is the fungus organism itself. Another is the host -- in our case, here, the grass plant on which the fungus can germinate, and develop, and live. The third is the climate -- let's define this more broadly as environment -- the composite of all weather conditions and other conditions at hand, which can favor fungal development.

If we look at this "climate" factor -- (or environment factor) -- we find it can be further divided into 3 important sub-factors:

1. The occurrence of favorable temperatures.
2. The presence of abundant food.
3. The presence of free moisture.

Of these three, from your point of view as turf manager, MOISTURE is by far the most important. Why? Because it is the only one which you can manage, or regulate, to obtain some measure of disease control! You cannot regulate temperatures except superficially, (as with light syringing to temporarily cool turfgrass leaves at the ground level to prevent wilting). Temperatures within certain ranges are part of the climate of your area. You cannot regulate the "food" supply of the fungus -- the grass -- except to try to improve it. Certainly you can't eliminate this "food supply" -- this grass is precisely what you're trying to protect and maintain!

Thus, the only sub-factor you can do anything about is MOISTURE -- AND, this you can regulate only within very small limits, when natural moisture (precipitation) is LESS than you want. That is, you can always add water when it doesn't rain or snow enough. You usually cannot, as a practical matter, remove excess water when it rains or snows too much.

As can be seen, therefore, CLIMATE in general, and MOISTURE, in particular, are important in disease development -- and you need to regulate these as best you can to favor the development of fine turf, and to oppose the development of fungi. It is important that this be done -- even the best fungicides can't do their job well in a climate that's ideal for fungi to grow and develop.

In addition to the weather aspects of "climate", you need to handle other aspects of turf maintenance properly before fungicides will provide effective disease control. Most important of these are the everday management practices you employ, as a turf manager. A wellknown turfman has told me he can control turf diseases without fungicides at all. And indeed he can -- by invoking management practices that won't permit fungi to develop. As an example, he says that when temperature is up, and humidity is high, inviting fungus activity, he can use a large propeller or fan to blow across the turf. This dries it out, and thwarts the fungi, who need the moisture and humidity in order to develop. This is a bit extreme, but you'll agree that good management practices, properly employed, will do much to avoid turf diseases. These would include (in addition to proper water management, mentioned above):

1. Selection of suitable soil mixtures.
2. Selection of disease-resistant grasses.
3. Proper surface and sub-surface drainage.
4. Maintaining sharp mowers.
5. Maintaining proper fertility levels.
6. Mowing at the best heights-of-cut for the grass, dependent upon the recreational demands of the turf.
7. Eliminating competition, such as crabgrass, goosegrass, poa annua, and the broadleaf weeds.
8. Eliminating turf insect pests.
9. Proper regulation of traffic.
10. Keeping down mat and thatch -- the breeding place of fungi -- via aerating, vertical mowing, etc.

Now -- it's a big mistake, as you well know, to assume that good physical management practices along, no matter how diligently they're carried out, will fully prevent fungus activity and turf diseases. They will greatly limit the sphere of activity of the fungi -- keep fungus population down to a bare minimum. But Nature provides ways for all life to perpetuate itself, even under the most adverse conditions. Fungi are no exception. They'll persist, and likely develop and attack grass to some degree, no matter what physical management practices are invoked. This means the ultimate step is needed to avoid fungus disease damage -- the proper use of good chemical fungicides. It is this, and this alone, which will give your turf the ultimate protection it deserves.

What is a "good" fungicide? It is simply a fungicide that is effective -- either in protecting the turf from fungus invasion, or in "stopping cold" a fungus invasion that has already started. Unless it is effective, just don't use it -- you'll be creating more problems than you solve -- and you'll waste good money in the process. How do you evaluate the effectiveness and overall suitability of a fungicide under

your conditions? There are many things to consider. Here are just a few of the important ones:

1. FOLLOW TURF EXPERIMENT STATION DISEASE RESEARCH. Watch expecially the work that's done in a dedicated and scientific manner -- with at least 3 replicates of every test -- and with adequate check plots! (Unless there are check plots infected with disease to compare directly with treated plots that are free from disease, you have no way to tell whether a given fungicide controls disease or not.)

2. READ THE RESEARCH REPORTS OVER A NUMBER OF YEARS! Be wary of a fungicide that "gives disease control" during one season, but not before or after -- or which appears effective in one place but no on similar turf a short distance away. Watch for the fungicides that have a history of outstanding control year after year, and in place after place, wherever tested. The continued outstanding success of some of the mercury, cadmium and broad-spectrum fungicides over periods ranging up to 40 years testifies to the excellent performance of these products under actual use on a long-term basis.

3. CONSIDER THE MANUFACTURER. If he's been around for a long time, and has made progress, you can be absolutely certain that his products have performed exactly as expected, at economical cost, and precisely as labeled. These products should be worthy of your routine use -- you'll get value received.

4. CONSIDER YOUR ASSOCIATES. If your fellow turf managers get excellent results under actual use conditions with the same fungicides proven effective at experimental stations, you have additional reasons for using them.

5. CONSIDER YOUR DISTRIBUTOR. No one -- but no one -- is so sensitive to what's good and what isn't, as is your distributor. He's the last one to go "all out" for any new product -- because before he takes it on, and pushes it, he wants to investigate all angles -- and be sure it is worthy of you. And he's the first to dump any product that doesn't perform -- because unless it does its job, he just won't risk doing you a disservice by selling it to you. Just another reason for giving all your turf products business to your distributor-- in a very real sense he's working for YOU.

6. CONSIDER PRICE LAST. An ineffective fungicide is expensive for you, no matter how low its "price" may be. Watch your COST -- not the per-pound "price" of the fungicide. In the first place, your fungicide program is only an infinitesimal part of your overall maintenance budget, in which your first 75%, roughly, goes for labor. Other big chunks of the budget go for equipment of various kinds. The "chemicals" part of your budget is small, relatively speaking, and most of it goes for fertilizers. Only a small segment goes for fungicides -- yet these are some of your most important "tools". Without them you just wouldn't

have greens or the other fine turf you want. You could double or triple your expenditures for fungicides -- and still not disturb your overall maintenance budget significantly. So -- you'll want to disregard "price" as such -- watch your COST -- select the fungicides that give you the disease control you want, at the lowest cost per 1000 square feet of turf per month -- or per year.

Once you've selected good fungicides, the question of using them properly becomes one of simply following, again, basic principles. You all learned these long ago, but we'll mention some of them by way of refreshing our thinking. Here they are:

1. WEIGHT YOUR FUNGICIDES -- No "volume" measurements are always correct for wettable powders, because their bulk often varies, depending on manufacturing procedures. (In the case of liquids, volume measurements, such as pints, quarts, etc., are usually O.K.)

2. MEASURE YOUR TURF AREAS -- Know the size of the area you're treating -- in terms of thousands of square feet. Use any one of the several simple measuring devices or techniques, such as the one at the top of our own application chart.

3. USE THE CORRECT AMOUNTS -- This means to use the dosages -- and timing -- spelled out in the directions. Using too little will result in inadequate disease control. Too much may cause turf injury. The manufacturer has spent plenty of time and money to determine the correct amount that will provide effective, safe and economical control.

4. WITH A FEW EXCEPTIONS, DON'T MIX FUNGICIDES -- In all cases, the manufacturer tested each fungicide by itself -- and his recommendations for each are based on using it by itself. The few exceptions are such tank mixtures as thiram and mercury, thiram and cadmium, and others that have been proven O.K. over the years. Beyond these, use each fungicide along. To do otherwise is to invite compatibility problems of extraordinary complexity, which could result either in lack of disease control due to components neutralizing each other, or in turf damage from toxic compounds that could be formed -- and often are.

5. WHEN POSSIBLE -- SPRAY --- If you have a choice, you'll usually find that spray application gives more thorough and uniform coverage than the same fungicide applied dry.

6. NEVER MIX FUNGICIDES WITH OTHER TURF CHEMICALS -- Incompatibilities have produced turf damage, in some cases, when a fungicide has been mixed with a soluble fertilizer -- or a herbicide -- or an insecticide. And in some cases the mixture just doesn't make sense. For example, we're often asked if one of our fungicides can be mixed with a pre-emergence herbicide. Now think about this for a moment. The fungicide should remain mostly on the grass blades, whereas the pre-emergence herbicide must be drenched into the soil. What would you do with such a mixture? If you leave the spray on the grass blades, you'll lose the action of

the herbicide which must control seeds in the soil. If you drench it into the soil you lose the action of the fungicide, which must be absorbed through the leaves. Common sense says--apply each separately.

7. SPRAY IN TWO DIRECTIONS -- Applying half the fungicide in one direction and the other half in a perpendicular direction will do much to achieve complete coverage and greater uniformity.

8. CONSIDER A COLOR INDICATOR -- Several are available. At very low cost small amounts in the spray solution clearly show the sprayed area -- and help achieve complete and uniform coverage, while avoiding excessive overlapping.

9. ALWAYS FOLLOW A PREVENTIVE SPRAY SCHEDULE -- If you see disease symptoms, grass already has been lost. Remember that you aren't paid to solve problems -- you are paid to avoid problems, including disease problems.

To illustrate a few of the things we've talked about here, and to confirm a bit the relationship between disease, climate or environment, and the proper use of fungicides, let's take a look at a few slides:

(SLIDES)

That concludes the formal part of this discussion, gentlemen. However, may I suggest, before signing off, that each of you get a copy of the article, "Fungal Diseases of Turfgrasses in California: Their Nature, Factors Influencing Their Development, and Their Control." This was written by Doctors Robert M. Endo and Arthur H. McCain, of two branches of the University of California, and published in the July, 1965 issue of CALIFORNIA TURFGRASS CULTURE. This is one of the best short courses in turf diseases I have ever seen, and I commend it to you most highly. To make sure you have the opportunity to get this, I've made a ditto of the article name and its source -- I hope each of you will pick up a copy and write for this.

Again, it's a tremendous pleasure to be here, and I thank you most sincerely for having invited me.

FERTILIZERS-- MAJOR ELEMENTS--

W. E. Gentry
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Mr. Chairman - Members of the Texas Turf Grass Association-

It is a pleasure to be with you today. It is always a pleasure for me to return to Texas A&M, even though my memories go so far back that some are painful. There were still a few boards around way back then.

Secondly, I enjoy being with golf course people. My wife accuses me of having more time for the golf courses than I have for her. Her sarcastic expression, when I start for the golf course on a bad day is, "Oh, I know it never rains or is never cold on the golf course."

By the way, I had an invitation to join a new society the other day that could put you golf pros. and managers out of business unless it is stopped. It is called Athletics Anonymous. They tell me that when I get the urge to play golf to call, and they will send someone to drink with me until the urge passes. I haven't joined yet.

My assignment on your program is a discussion of the major plant food elements. For some reason no one worries about beautiful, green, healthy grass, but when it fails to grow vigorously and show that lush green look then the greens committee squalls, "My God what has that stupid greens keeper done now?"

I hope in this discussion of the 3 major plant food elements you might gain some helpful information as to what does make plants grow vigorously. Proper fertilization is one of the basic factors. There is nothing magical or mystical in fertilizers. (Though some glamour outfits might try to lead you to think otherwise.)

As long as 125 or more years ago, Justus van Liebig explained for the first time the nature of plant nutrition. He showed that certain materials increased crop growth because they contained Nitrogen, Phosphorus, and Potassium, along with certain other elements. We will consider only the three NP&K for someone else will discuss the others with you.

On every bag of fertilizer you buy you will find a guaranteed analysis stating the percentage of these three elements, Nitrogen, Phosphate, and Potash. Let's take these elements individually and discuss their functions in plant growth. I don't think you can place them in any order of importance because all must be available in adequate amounts to have that beautiful golf green or fairway that makes greens committees happy.

I will start with nitrogen simply because it always is listed first in any fertilizer analysis. Nitrogen, I think of as the rum in a Rum Sizzle. Now a rum sizzle is an exotic Caribbean drink made of sugar, milk, and rum. The sugar gives you pep, the milk gives you energy, and the rum gives you ideas about what to do with all that pep and energy.

Nitrogen is a colorless orderless inert gas and constitutes about 80% of the air, but plants other than legumes cannot use pure nitrogen; nor can it be put in fertilizers in this form. Pure nitrogen must be combined with other elements before it can be put in fertilizers. There are too many combinations to discuss in this short time.

Most soil nitrogen is present in the organic matter in the top few inches of soil. As soils vary in their organic content, so also do they vary in their nitrogen content.

Fortunately, we have unlimited resources of nitrogen. In the air over every acre there are 35,000 tons of nitrogen that can be utilized by synthetic nitrogen fixations processes.

It is fortunate that sources are unlimited, for nitrogen is quickly exhausted from most soils by erosion, leaching, and by growing plants which require large quanities, and therefore nitrogen must be replaced frequently to maintain soil productivity.

The functions of nitrogen in plant growth: (I will list)

1. Induces growth.
2. Gives dark green color to plants.
3. Improves quality of leaf crops.
4. Feeds soil micro-organisms during their decomposition of low nitrogen organic materials.

From these functions you can see why nitrogen might be compared to the rum in a rum sizzle. You can also see from these functions that there can be visible signs in the plant when nitrogen supplied in soil are inadequate or deficient.

These deficiency signs or symptoms are:

1. Sickly yellowish-green color.
2. Distinct slow and dwarf growth.
3. Drying up or firing of leaves starting at the bottom of plant and proceeding upward.

Two other points I hope you will always keep in mind--One is that temperatures affect nitrogen responses in turf grasses to a very great degree. While temperatures remain cool, under 80°, nitrogen will stimulate foliage growth; but at high temperatures, over 90°, nitrogen reduces and weakens stands. And two, as the amount of nitrogen is increased the foliage of the plant will become more soft and succulent

which makes the plant more susceptible to disease and injury. Because of these very important facts you should turn to the slow release forms of fertilizers in the hotter months.

Enough for the rum. Let's get on to the milk in my drink, or phosphorous.

Phosphorous, I think of as the milk in the sizzle drink, or the energy factor. It is a vital constituent of every living cell and without it there can be no life. Pure phosphorus is a highly active element that must be stored in water for when it is exposed to air, it will burst into violent flame. Pure phosphorus like pure nitrogen, cannot be used by plants or put into fertilizer in this form, but must be combined with other elements. There are many combinations suitable for use.

Native soil phosphorus in the vast majority of cases is "bound" or "fixed" in very insoluble forms, so that only a very small part of the total supply may become available within a growing season. For this reason it is highly important to add phosphorous to practically all soils. This country is fortunate in having nearly 1/3 of the total known world supply of Phosphorous --- About 15 billion tons in the form of rock phosphate.

Except for nitrogen, unsatisfactory plant growth more often is due to a shortage of this element than of any other. Phosphorous is intimately associated with all life processes and preforms some of the following functions in plant life.

1. Stimulates early root formation and growth.
2. Gives rapid and vigorous start to plants.
3. Gives winter hardiness to fall seeded grasses.
4. Is extremely important in germinating seedlings.

There are also certain signs or symptoms that are visible in the plant when phosphorous supplies in the soil are inadequate or deficient. These deficiency signs or symptoms are:

1. Purplish leaves and stems.
2. Slow growth.
3. In winter grasses, lack of stooling.

Outside factors such as temperatures do not seem to greatly affect the plants response to phosphorous.

So with the first two ingredients of our drink, we now add the third, the sugar for pep. Of course, it will be Potassium in the drink for turfgrasses.

Speaking of pep, I heard a story some time ago about one of your board members, Mr. Sam Locke. I hesitate to tell it for it might be made of whole cloth. Anyway, so I'm told, it happened years ago when Sam was out beating the brush. He had to work for a living then. His car broke down on him on night in the country during a terrific storm.

It was too cold to stay in the car so Sam hoofed it to the nearest farm house and begged to be put up for the night. Finally, the old farmer relented and said all right, but "Feller, I ain't got no daughter for you to sleep with." Sam was heard to reply, "Oh hell, how far is it to the next house?"

Back to business or potassium. Potassium in its pure state is highly reactive and dangerous to handle. And, of course, in this state cannot be used by plants or put into fertilizer. It too must be combined with other elements before it can be used by plants or put into fertilizers.

With this element nature has been kinder to us than with the other two, because there are natural deposits of potash in such form as to be readily available for plant use. There are known commercial deposits in this country sufficient to last for several generations with even more resources to be evaluated.

The functions of potash in plant growth are not so defined as with nitrogen and phosphate. For so far as in now known, plants do not build it into the structure of any of their parts. Certain functions for the element in plant growth have been proved however, which are:

1. Imparts increased vigor and disease resistance.
2. Produces strong stalks.
3. Essential to the formation and transfer of starches, sugars, and oils.
4. Imparts winter hardiness
5. Imparts drought resistance.

There are also certain signs of symptoms that may be visible in the plant when potash supplies in the soil are inadequate or deficient. These signs or symptoms that might be visable are:

1. Firing may start at the tip of the leaf and proceed downward on the outside leaving the midrib green.
2. Thinning of stand may be first indication, with speckling or diseased appearance of leaves.
3. Sods may have the appearance of suffering from severe drought during mid-day though moisture supplies are ample.

As I stated before, the functions of potash in plant life are not so well defined as with nitrogen and phosphate; but do not let me leave any doubt that potash is not just as essential as either, or both, of the other major plant food nutrients.

I have spent some time discussing with you what you receive when you buy a bag of fertilizer, and what the functions of the different nutrients are. And, assuming you remember it all, the information will be nearly useless, unless you use the fertilizer you buy efficiently.

Let me list some of the important steps in the efficient and profitable use of fertilizer.

1. Follow the recommendations of your agricultural college, or as in this case turfgrass assn., or the recommendations of sound reputable manufactures.
2. Use soil or tissue tests whenever possible.
3. Remember that fertilizer does not take the place of lime or organic matter.
4. Fertilizer will not over come poor insect, disease, or weed control programs.
5. Use adequate quanities and apply at the right time.
6. Observe and use your good judgement.

This last point leads me to impress on you to work out in advance a good, sound over - all program of fertilization, liming, disease control, insect control, and weed control. For without a good program your efforts will be about as wasted as the smile on the face of the girl with a 42" bust.

THE ANATOMY OF THE GRASS PLANT

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Presented to: Texas Turfgrass Conference; December 7, 1966.

I. General Morphologic Characteristics:

A. Grasses - annual or perennial herbaceous plants having hollow or solid, round to oval stems with prominent nodes; the leaves are two-ranked, and alternate linear, parallel veined, and usually have a split sheath clasping the stem. Grasses have a finely-branched fibrous root system.

B. Parts of a grass plant.

1. - Stem - The jointed stem of a grass is called a culm and is made up of a series of nodes and internodes. The internode may be either hollow or solid but the node (joint) is always solid. The culm may be erect, spreading (decumbent) or creeping (prostrate), and may be simple (non-branched) or freely branching. A branch or a leaf is borne only at a node, with the branch arising in the axil of the leaf sheath.

In certain grasses stems or modified stems arise at the base of the culm under the ground, spread out horizontally, and in time, send up new plants (shoots) and more fibrous roots. Bermudagrass and Kentucky bluegrass have such modified stems called rhizomes. A rhizome, being a stem has nodes, internodes and leaves (reduced to small scale-like structures) and usually is colorless.

In grasses such as Centipede, Carpet or St. Augustine grass, horizontal stems are borne at the base of the culm but remain on top of the ground. Such stems are called stolons and are jointed, green in color, bear true leaves at each node and send out roots from each node when it comes in contact with moist soil. Most bermudagrasses have both rhizomes and stolons.

2. - Leaf - The grass leaves are borne alternately on the culm in two ranks with only one leaf arising at each node. The leaf consist of four structures (sheath, collar, ligule and blade). The sheath is the portion of the leaf that envelopes the culm above the node; the margins usually overlap but are open (split). Rarely, however, the sheath may be partly or completely fused (closed) around the internode. The blades usually are flat (strap-like), narrow and attached to the sheath in a sessile manner. The region of thickened cells at the junction of the blade and sheath is called the collar. The cells of the collar region are meristematic and account for the elongation of the leaf blade. Upright from the collar a membranous or hair-like structure arises called a ligule. Some grasses have a lateral outgrowth from the collar region called auricles. The auricles are claw-like structures that clasp the internode, helping to keep the sheath close to the stem.

3. Inflorescence - Generally, the flowering head of a grass is is called an inflorescence. There are three types of grass

inflorescences; the panicle, raceme and spike. The basic unit of a grass inflorescence is the spikelet composed of one or more florets. The spikelets are grouped on the main stalk of the inflorescence (axis or rachis), being attached sessile to the rachis or by one or more branches or branchlets.

The panicle is the most common of grass inflorescences. It is a compound or branched inflorescence having an axis, branches off the axis, and the spikelets supported by pedicels.

The spike inflorescence has a central stalk or rachis and the spikelets are attached directly to the rachis without further branching.

The true raceme is rare in grasses. In the typical receme, the spikelet are subtended by pedicels directly off the rachis, but there are no branches. Many modified racemes, spike-like racemes, or compound spikes are common in the grass family.

4. - Spikelet - A typical grass spikelet consists of a short axis called the rachilla, two gluems and one or more florets. The floret is the lemma, palea and seed.

Examples of Grass Species and Morphologic Structures

Kentucky bluegrass - panicle - erect plant - rhizomes - form sod under frequent close mowing.

Redtop (Representing Bentgrass) Panicle - erect rhizomes - forms sod under frequent mowing.

Ryegrass - Spike - erect - annual - forms fair sod with heavy seeding rates and frequent mowing.

Bermuda - Multiple spike - prostrate - rhizomes, stolons, seed type reproduction - withstands close mowing and heavy use and abuse.

Carpet - Multiple spike or modified raceme - simular to bermuda but no rhizomes, larger leaf

Dallis - Modified raceme - semi- erect - assumes prostrate growth habit with frequent mowing. Most of food reserves in crown. Requires more careful management.

Bahia - Modified raceme - more erect than dallis, very leafy and scaly rhizomes - still more careful management to maintain stands, otherwise, similar to dallis.

II. What do these morphologic differences mean in terms of turf management practices?

The "best" turfgrass, like the "prettiest" girl, is a matter of opinion and personal preference. Each grass has advantages and disadvantages. A quality of one grass considered an asset in one turf situation may be a liability in another.

Southerners have a wonderful array of warm-season grasses from which to choose. Some of these grasses are older than the South itself, others were only a gleam in the plant breeder's eye less than ten years ago. Old or new, there is a fine turfgrass to fit every taste, pocketbook and need.

I have just briefly outlined the general morphologic characteristics of grasses but this does not begin to describe the wide variety of differences to be found among these numerous grasses. These more detailed differences may be instrumental in the variety choice you need to make.

Certain grasses grow well in the shade, others require full sunlight. Some grow vigorously, others are slow in their growth rates. For rapid establishment, a fast-growing grass is desireable, later however, when it is time to mow that apparent advantage may become a disadvantage.

Some grasses have erect or bunch habits of growth and may be quite

satisfactory for turf areas that do not require frequent or close mowing. Frequent close mowing on such a species may so reduce the leaf area that carbohydrate accumulation is greatly reduced, and subsequent recovery ability is at a very low level. On the other hand, grasses with a prostrate or sod-forming growth habit may be very well suited to such frequent defoliation practices.

Even within the sod-forming and densely growing types of grasses such as bermuda a great deal of variation still exists. Some varieties have rather coarse stems, long internodes and relatively few leaves per unit length of stem. Certainly not the type of grass you would choose for a golf course green, but it might be quite satisfactory for fairways, tees, parks, athletic fields or other similar areas. Selecting the right grass can save you money by reducing the labor and management expenses required to maintain a good sod.

Texture and color of the grass can be an important feature of a turf area. Some grasses have leaves that are fine and very soft and have the appearance of a living room carpet when properly mowed, watered and fertilized. The leaves of other grasses are coarse and harsh. The fine leaved grasses generally require more care. Colors vary over a wide range from yellow-green to a dark bluish-green and this feature may influence your choice.

Some grasses are highly susceptible to disease and insects. These must be closely watched and promptly treated with the proper fungicide or insecticide. Others are able to shrug off these pests with a minimum of assistance from the manager.

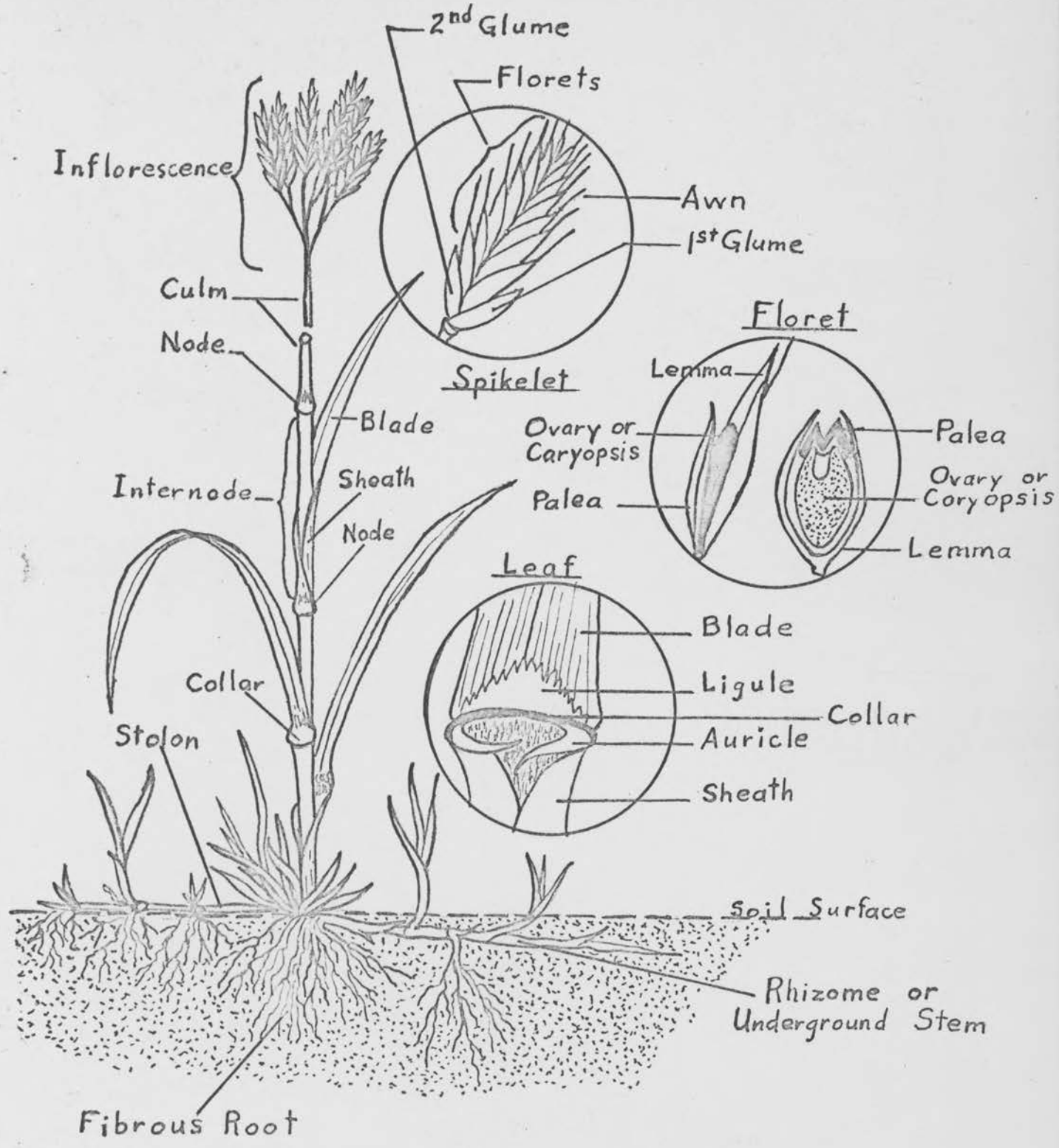
Grasses, like people, have different appetites. One grass may need as many as six applications of plant food per season. Another may be perfectly content with only two feedings per season.

The use of agricultural chemicals (fertilizers, fungicides, insecticides, herbicides) probably are used more widely in turf work than in any other field of agriculture. The kind of chemical you can use may depend on the grass you have in your turf area. We are now able to take certain grasses (weeds) out of other grasses with chemicals. In many cases, the control of one grass in another is based on the leaf structure. A broad, flat, open leaf blade may receive a lethal dose of a chemical while a narrow, short, tapered leaf may receive so little of the chemical that the grass escapes injury.

Which grass do you prefer? As the old saying goes, "Differences of opinion are what sell land and marry ugly women." The choice is yours.

Wait, before you select the grass that suits you or your specific need there is one other aspect that you may wish to consider. As you all are well aware, bermudagrasses in the South fills many of our turf needs particularly on home lawns. But remember, bermudagrass if fertilized and watered for best growth and development, it is necessary to mow the area every 3 to 5 days. If such a schedule interferes with your hunting, fishing or golfing - select another grass - bermudagrass is not for you. Or, maybe if you are lucky you can get your wife to mow it.

In summary, when selecting a grass to do a certain job, do not overlook the detailed anatomy of the grass in question. Find out all you can about the way the grass grows the way the various structures respond to treatments that you plan to impose. You may be able to save yourself a lot of costly mistakes.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Floret
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Blade
Ovary or Caryopsis
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Internode
Shoath
Ovary or Caryopsis
Palea
Node
Lemma
Leaf
Blade
Ligule
Collar
Collar
Auricle
Stolon
Sheath
Soil Surface
Rhizome or Underground Stem
Fibrous Root

GRASS PLANT