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TEXAS A&M UNIVERSITY

and

THE TEXAS TURFGRASS ASSOCIATION

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FOREWARD

We take this opportunity to express our appreciation to all of those who helped in conducting the 24th Annual Texas Turfgrass Conference. It is only thru their hard work and dedication to the profession of Turfgrass Management that this Conference continues to enjoy such great success.

Our special thanks to the chairmen and to the speakers whose talks have made this publication possible. It is hoped that these proceedings will be of some value in growing high quality turf.

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Program Chairman

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AM I A GOOD LABOR MANAGER?

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I. To answer such a question as "Am I a Good Labor Manager?" one must compare how he manages his labor with the fundamental principles on the subject. So, what I will do for the 30 minutes assigned me on your program is review the key aspects of labor management. You can ask yourself, as I move along, "Is this the way I do it?" If your answers are "no", there might be some potential for changing.

II. I will cover the following four areas of personnel management.

A. Hiring an employee

B. Breaking in the new worker

C. Continuous training

D. Supervising workers

III. Key principles and processes

A. Getting ready to hire

1. Outline the exact duties to be performed -- in writing

a. Lines of supervision should be clearly set

b. Means the whole operation has to be studied -- how jobs fit together -- layout -- procedures

c. Prepare step-by-step job procedure, with times of day listed, in Spanish for Mexican labor. Simple but complete

2. Set the wage and other benefits

a. Comparable in firm

b. Competitive in area

c. Housing -- give it fair rental value

d. Livable

e. Incentive systems to be discussed a bit later in this paper.

B. Look for worker

1. In small businesses, too often the man is located and then the job is built around him

2. Sources are many -- ads, employment agencies, etc.

a. Best source is present workers

C. Interview applicants

1. Check attitude as well as skills

2. Explain company policies, rules, etc.

a. Let applicant tell you how he would like to be supervised

3. Let unsuccessful applicants know in writing they did not get the job

D. Break in a new worker right

1. Build job induction around these basic human characteristics:

a. Feeling conspicuous

b. Scared of unknown

c. Desire to make good impression

d. Does not want to appear stupid

e. Knows no one

f. Wants to be accepted

2. Procedure

a. Re-interview

b. Give him a written sheet or booklet on rules, etc.

c. Immediate supervisor properly introduces new worker to other employees

(1) Explain entire operation

d. Put him on job

(1) Tell him

(2) Show him

(3) Let him do it and tell you why

(4) Follow-up -- go over job procedure steps

E. Keep them motivated and productive

1. Make supervision as easy as possible

a. One way which I want to discuss briefly, since it is new to many types of businesses, is an incentive plan

2. What is an incentive plan?

a. Is where compensation is based on measurable productivity -- goes up when production goes up -- vice versa

b. Principles of incentive plans

(1) Base pay is the floor for average production

(2) Incentive pay is scaled on increases in production which are within reach -- not impossible

(3) Rates of incentive pay are such that owner still gets enough extra net income from the increased production to make it profitable for him

(4) Key to any plan is that excellent records must be kept

(5) They cause the workers to view their job in the same light as the owner -- more efficiency means more income

3. A few basic principles of supervision

a. One boss <u>only</u> for everyone

b. Group similar tasks into jobs -- makes training much easier. Make work easier

c. Span of control -- Right doses of supervision

d. Delegation -- in balance

e. Special projects -- use work order system

IV. Benefits to be derived from practicing modern personnel management

A. Increased production

B. Lower unit costs

C. Reduces lost motion and duplication of effort

D. Greater feeling of security by workers

E. Makes managing easier

F. Favorable business image in community

PRINCIPLES OF LANDSCAPE DESIGN

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The profession of Landscape Architecture is concerned with man's modification of his environment and as such with the organization of space -- outdoor space -- for man's total living environment. This profession is a relatively new member of the design disciplines that are concerned with planning for people and the problems created by people. The profession is divided into three phases, namely: Landscape Design; Landscape Construction and Landscape Maintenance.

Lanscape Design is the phase that is to be discussed with you this morning. Landscape Design is a thought process whereby plans for a given area of land evolve through a series of methodical steps based on an analysis of the problem and certain related facts. Based on this analysis, a logical conclusion in the planned use of an area by people should result.

Landscape Design consists of two major aspects -- functional or use and aesthetic or beauty. For the social pattern of our world a designer must consider both aspects of design and never sacrifice one to benefit the other. There should always exist a planned consideration for both aspects. Space is always modified so that people will find it both useful and beautiful.

There are three primary factors that shape the development of landscape architecture -- people, time and technology. The needs of people to meet the challenge of their social pattern in a changing world is the primary concern of the landscape architect. He must concern himself with designing space to preserve and create man's total living environment to provide him with genuine living experiences. In today's changing world, through research and study the Landscape Architect is meeting the challenge of the changing aspects of design phenomena.

To emphasize that Landscape Design is a thought process, these words from LANDSCAPE ARCHITECTURE by John Simonds are quoted:

> "Man alone of all creatures has the ability to weigh the factors of a problem and reason out a course of action. He is able, moreover, to learn not only from his own experiences but also from the disasters, the triumphs, and the lesser experiences of untold thousands of his fellows. He can borrow from, and apply to the solution of any problem, the accumulated wisdom of all mankind.

Basic Principles of Landscape Design

The observation has been made that the designer of outdoor space is concerned with two major areas -- (1) Preservation of existing beauty; and (2) The creation of additional beauty. Everyone has an idea or definition of the term beauty, therefore additional discussion of this term will not be done. In this day of emphasis on conservation of our natural landscape further development of this area is not necessary as we are constantly appraised of the world around us.

> "The most significant feature of our modern planning is not the scale of our structures, nor the scope of our developments, but rather our utter disdain of nature and our seeming contempt for topography, topsoil, air currents, watersheds, and our forests and vegetal mantle. . . .For the moment, it seems, we have lost our touch. Perhaps, before our planning can progress, we must look back. We must regain the old instincts, relearn the old truths. . . . fully aware of nature's forces, forms, and features; respecting and responding to them; adapting them. . . .we must rediscover nature."[2]

Contrary to popular belief there are no rules for landscape design but rather there are the "old truths", principles of design that have evolved through the centuries to guide those who practice in the disciplines of the fine arts. Really good design survives through the ages because it satisfies, and it satisfies because it is a result of the application of the basic principles of design in the expression of the artists.

To attempt to catagorize the various and sundry PRINCIPLES OF LANDSCAPE DESIGN is rather difficult because these are not static units. Due to the flexibility of interpretation by various designers there sometimes results a feeling of confusion with our lay public. In an attempt to stabilize the thinking in this area and to provide a base for discussion the PRINCIPLES OF LANDSCAPE DESIGN have been reduced to six and will be developed for your information.

BEGIN SLIDES

1. PROPORTION: (Relativeness, correlation, fitness, part, order, ratio, portion, rate, relation, quota). The relation of one part to another or to the whole, with respect to magnitude; the relative size and arrangement of parts; as the proportion of the parts of a garden; the size relationship of one area to another; the proper use of amounts, quantities, groups, or units.

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[2] Ibid. Pages 3 and 4.

2. SCALE: (Degree, gauge, relativeness, size relationship, graduation). The size relationship of the parts of an arrangement or composition. A unit of measure usually related to the human figure. The relative dimensions without difference in proportion of parts; size or degree of the parts or components of any complex; thing compared with other like things; as a plan drawn on a scale of one inch to a foot. A standard of known dimensions which in landscape design must relate to units that are usable by people. Man has always been considered as the unit of measurement (scale) in the landscape but the automobile may replace man as this design criteria. Scale unites man and his environment.

3. BALANCE: (Equilibrium, offset, completeness, stabilize, symmetry, counterpoise, equalize). To have equal weight on each side; to compare, by estimating the relative force, importance or value of different things. Balance is a quality that stabilizes all units of a composition and it deals with visual weight relationships throughout a composition. It is quickly recognized and the mind reacts to the sense of equilibrium as one moves through a composition. Three forms of balance are employed in landscape design: (1) symmetrical or formal; (2) asymmetrical or informal; and (3) spatial. Symmetrical is based on bilateral symmetry and is stiff, hard, and static. It is easy to create but difficult to maintain. Asymmetrical is balance to the eye, unequal forms or masses stabilizing each other. Both of those forms are axial in concept and depend on axial viewing for full value. Spatial balance is not based on axial development but rather on the concept that from any given point in a composition a feeling of stability in design is apparent. It is involved with the manipulation of individual units within the total space to provide a stable environment.

4. DOMINANCE: (Influence, accent, focalization, prevail, attentive, conspicuous, predominant). To influence most prominently; to have the greatest effect upon; to overshadow. This principle of design is used to dramatize a certain part of a composition or to accentuate a special area of the composition. Dominance may be in the form of an architectural unit or it may take the form, color or texture of plants. Equal values of dominance will detract or negate this principle. A careful use of dominance creates interest in any composition; however, many well designed compositions do not use this principle.

5. RHYTHM: (Recurrence, periodicity, motion, tempo, uniformity, symmetry). The measure of movement by regularly recurring, motions, impulses, forms, etc. In landscape design this principle is used to achieve a feeling of movement either physical or mental or both. Rhythm is achieved through repetition of form, color and texture of both architectural materials and plant materials. Selection and placement of plants provide for the employment of this principle. Rhythm can easily become monotonous so it must be handled carefully. Subtle employment of rhythmic units can be a real asset of design.

6. CONTRAST: (Contrariety, difference, dissimilarity, different, opposing, counteracting). To set in opposition different things or qualities; to compare by differences; the act or process of contrasting; the placing together in view or in juxtaposition things of the same category or class but widely differing from each other, in order to render the difference more vividly marked. The harmony of contrast adds interest to a design and prevents monotony. This principle is used in the placement of architectural units in relation to the placement of plant materials. The identical responses are generated as when contrasting color harmonies are employed.

All of these are the primary laws of order, the basic truths that have been accepted through the ages in guiding design. These principles never change but the medium of expression can and does change. When a designer employs these principles the resulting composition will be one of harmony and unity of expression. All of these principles provide an overvalue of completeness of a design concept.

Although not a principle of design one of the greatest virtues of any design is simplicity. An uncluttered design cleanly delineated always delivers the message.

These principles of design are employed in the selection and placement of plant materials. Plant materials continue to be the primary medium of expression for the landscape designer and as such these materials have varying values. The most important plant material is considered to be turf -- in whatever form is available to stabilize the soil. The land must be secured to prevent erosion and to provide a base on which to build a satisfactory landscape. For this reason your organization and your work is of paramount importance to landscape designers. Trees rank second in importance as a medium of expression to the landscape designer as these plants are used for definition of vertical space. Shrubs provide elements of scale and transition to a composition and present a humanized relation to the landscape. Auxiliary plants are the flowers, bulbs or plants for seasonal color that support the other plantings.

Principles of Landscape Design properly employed create additional beauty to man-made beauty in the organization of space for man's total living environment. Every American is entitled to the exposure of beauty as an integral part of the American way of life.

"EVERY EXPOSURE TO BEAUTY MAKES IT'S CONVERTS"

CONTROL YOUR INSECTS

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There are many pests of turfgrass and it is impractical to discuss each in detail. Also, some insects are more pestiferous at certain times under optimum conditions than during other similar or unlike conditions. For example, the sod webworm is occasionally a very destructive pest of lawns but there may be a period of a few years when this insect is of no economic importance. Apparently optimum conditions conducive to outbreaks of this pest are unknown or at least unpredictable in this area.

The cost involved in controlling insects attacking turfgrass is mounting annually. Added to the monies spent for disease control, fertilizing, caretaking, etc., the maintenance of lawns has become one of the largest businesses over most of the United States. However, fortunately all lawns are not attacked by most or all of these pests. Also, homeowners and turfgreen keepers are becoming more alert to prevention and/or control of these pests. Unfortunately, especially in the case of some, very little if any attention is given to the upkeep of lawns. Consequently, this negligence is costly to his neighbors because the pressure for control of insects in nearby lawns is increased.

I find that "Trade Named" insecticides are confusing to the layman because many of the users are not cognizant of the importance of reading the label, and also following directions for use even though they are aware of the specific chemicals they use. Naturally misuse is not only detrimental to the user but "gossip" broadcast of unduly results frequently influence his friends, neighbors, and social acquaintances. At least such impressions occur among people in the area where I live.

CHINCH BUG:

The southern chinch bug (*Blissus insularis* Barber) is perhaps the most destructive of the pests that attack St. Augustinegrass. There are other closely related species of chinch bug, i.e., *Blissus leucopterus*, which damages field crops such as corn, grain sorghum, oats, wheat, barley and rye. However, as far as known this species does not feed on St. Augustinegrass.

The southern chinch bug has piercing and sucking mouthparts with which it sucks the sap from foliage, stems and roots of the host plant. Both nymphs and adults cause damage which can be detected by the appearance of discoloration and wilting of the plants (and eventually death of the plant). Early detection of the presence of this insect is important in order to control it before "dead spots" appear in the lawn. The nymphs probably do more damage than the adults. The adult is about one-sixth of an inch in length, have a black body, reddish brown legs and two pairs of white wings. The wings do not fully cover the sides of the abdomen, consequently a small black area is present on each side. The young nymph is reddish with a "dirty white" band across its body.

Various methods are used to find this insect. If present in large numbers, nymphs and adults can be found by parting the grass in the edges or near grass damaged areas. Some prefer to use the "can method". This involves the use of a can or metal cylindrical container with each end open. One end should be sharpened and forced downward in the sod. Exert pressure at the top of the can and fill with water. If considerable thatch is present, the grass inside the can should be "stirred" with one hand. Within one to five minutes the nymphs and adults will float on top of the water. Count the insects (nymphs and adults). Most recommendations state that treatment should be made if as many as 10 are found per square foot of lawn. Although St. Augustinegrass is perhaps the preferred host they have been reported to attack bahiagrass, zoysiagrass, torpedograss and centipedegrass. Common bermudagrass is seldom fed upon.

The life cycle (egg to adult) is completed in 6 to 8 weeks. Winter in most, if not all, areas of Texas is spent in the adult stage in sheltered areas within or near the lawn. The adults become active in the spring and deposit eggs in the root area. It is not uncommon for the first damage to occur in the sunny areas of the lawn, especially near concrete walks and driveways.

BERMUDAGRASS MITE:

Almost all mites, especially the bermudagrass mite, is very small (microscopic) and multiplies rapidly; consequently severe damage may occur within a short time. It is oblong and white and more or less the shape of a cigar. Eggs are deposited on any accessible part of the plant. Eggs hatch into six-legged young (larvae), then transform to nymphs which have eight legs. The adults also have eight legs. A life cycle requires about one week. The pest sucks the sap from grass stems and leaves causing the plants to turn yellow to light brown. The grass plants become stunted and bushy and short internodes of the stems are common.

A BERMUDAGRASS SCALE is sometimes injurious to bermudagrass, however it is not as difficult to detect as is the mite. The oblong adult is covered with white, hard waxy secretion which is approximately 1/16 inch long. It, as the mite, sucks juices from the plant.

RHODES-GRASS SCALE:

Adults of this insect are about 1/8 inch in diameter, globular in shape, dark purplish brown and covered with a felt-like white, cottony secretion and are not difficult to see. All, except the young stage (crawlers), are sessile and legless. Apparently, the waxy covering is for protection. The adults (only females occur) give birth to the living young (larvae) which disperse by crawling to nearby areas. They are also scattered by winds and animals, especially birds. The crawlers (larvae) make their way into the leaf sheath at a node or crown of the plant before transforming to the immobile stages (nymph and then to adults). Hosts of this insect are primarily bermudagrass and St. Augustinegrass in South Texas, however they have been found in other areas of Texas. They can be transported in grass sod.

LEAFHOPPERS:

Leafhoppers are wedge-shaped, frequently mottled insects that fly or hop when disturbed. They are less than 1/5 inch long and are green, yellow or brownish gray.

Most species overwinter as adults; a few overwinter in the egg or nymphal stage. Eggs are inserted into the tissue of the host plant. These hatch in 5 to 14 days and produce nymph which resemble the adults except in size and the presence of wings. There are commonly from one to four generations annually.

Many species of leafhoppers infest lawns, sucking sap from grass leaves and stems. New lawns may be damaged so extensively that reseeding is necessary. Damage to established lawns is generally negligible unless the lawn also suffers from moisture or fertilizer deficiencies.

CHIGGERS, Trombicula spp.

These are the familiar red-colored mites that are so troublesome. The small, red adults may be seen travelling slowly over the surface of the ground. The females die soon after depositing their eggs in soil. The active feeding stage or first instar larva has three pairs of legs, is reddish and small enough to be difficult to see.

Eggs laid by the female hatch into immature chiggers called larvae. Only the larvae are parasitic on man and animals. Larvae transform into nymphs and the nymphs into adults. Nymphs and adults feed on insect eggs, small insects and other organisms found on or near woody decaying substances. The adult of the common chigger spends the winter in an earthen cell, about 1 to 1 1/2 inches deep in the soil.

Chiggers do not damage grass but are pests to animals and human beings. On warm-blooded animals, larvae search for a suitable location to feed. They prefer parts of the body where clothing fits tightly or where flesh is thin, tender or wrinkled.

Chiggers insert their mouthparts into the skin and then inject a fluid (enzyme) which liquefies the tissue. This fluid causes reddish welts, swelling, itching and fever in sensitive individuals.

A chigger attached in a pore or at the base of a hair may be so enveloped in swollen skin that it appears to be burrowing into the skin. But chiggers do not embed themselves in skin.

When suffering from chigger bites, take a bath as soon as possible; then apply antiseptic to each of the welts. This kills any chiggers not killed or removed by the bath, and it helps prevent infection. Destroying chiggers reduces itching but does not stop it. Fluid injected by the chigger causes itching. No practical way to remove chiggers has been found, and no treatment is known that will give permanent relief from itching.

SOD WEBWORMS:

Sod webworms are the larvae of lawn moths. Adults are small, whitish or gray moths with a snout-like projection in front of the head. Wings are folded closely about the body when at rest. The larvae or sod webworms are about 3/4 inch long, slender and light brown with dark spots.

Lawn moths hide in shrubbery or other sheltered spots during the day. In early evening, they fly over the lawn and the females scatter eggs. The eggs hatch in about 1 week, and the larvae being feeding. These insects remain larvae for 3 to 4 weeks, then pupate. Adults appear about 1 week later. A life cycle is completed in 5 to 6 weeks, with several generations in a year. They overwinter in the soil as larvae in silken webs.

The newly-hatched larvae feed on grass and, as they grow, build burrows or tunnels slightly below the soil surface. They cut off blades of grass, drag them into the burrows and eat them. Sod webworms feed only at night, remaining in their silken webs during the day.

The first signs of sod webworm damage are areas of unevenly cropped grass and patches of brown or dying grass. Soon large areas may turn brown and die.

Extremely close observation is required to detect larvae in lawns. Sod webworms can be detected by examining the grass at the soil surface for webbing. These larvae also can be found by breaking apart some of the drying sod. If there are three or four larvae within a 6-inch square section, an insecticide treatment is recommended.

FALL ARMYWORMS, Spodoptera frugiperda (Smith)

The adult is an ash-gray moth. Its forewings are mottled with irregular, white or light-gray spots near the extreme tip. Forewings of the female are much duller than those of the male. Hindwings of both sexes are white with a narrow, smoky-brown edge. When expanded, the wings are about 1 1/2 inches across.

Newly hatched larvae are white with black heads. Their bodies darken as they feed until they are full grown. Full-grown larvae are about 1 1/2 inches long. Their color ranges from light green to almost black with several light stripes along the body. The front of the head is marked with an inverted white "Y".

After mating, female moths lay their eggs at night on leaves of grass. Eggs are laid in masses of 50 to several hundred, and they hatch into larvae in 2 to 4 days.

During growth, they may curl up in leaf sheaths, suspend themselves from plants by threads or move about on the ground. Fall armyworm larvae complete their feeding 2 to 3 weeks. Then they burrow an inch or two into the soil, make small cells and pupate. In 10 days to 2 weeks, the moths emerge. The fall armyworm may have as many as six generations a year.

The fall armyworm is one of the most destructive insects to lawn grasses in certain years, particularly bermudagrass. Most severe outbreaks usually occur following a cold, wet spring.

Young larvae feed on the lower surfaces of leaves, leaving the epidermis intact. At first they eat only tender parts of leaves. Later, as they grow, they devour all foliage during the day. If forced by hunger to seek other food, they may migrate in the daytime. The larvae may attack and devour one another when crowded or migrating.

WHITE GRUBS:

White grubs are the larvae of several species of May or June beetles. They are white or gray, have a brown head, six legs and usually lie in a curled (C-shaped) position. Full grown larvae may be 1 1/2 inches long.

Most white grubs spend about 10 months in the ground; some remain 2 or 3 years. In mild weather, they live 1 to 3 inches below the soil surface, while in winter they move deeper.

White grubs burrow about an inch below the soil surface and feed on grass roots. Damage appears as areas of dead, dry grass. Grass in infested areas can be lifted out of the soil very easily or rolled back into a mat of runners and foliage. Grubs often can be found between this mat and the soil.

MOLE CRICKETS:

Mole crickets can be recognized by their broad, shovel-like front legs. With these legs, mole crickets burrow into moist, light soils for food. This burrowing often results in the roots of plants being severed and seedling plants uprooted. Newly seeded lawns are especially susceptible.

ANTS:

Several species of ants may build nests in lawn turf. Some ants form hills around the openings of their nests; fire ants build large mounds. The ant hills or mounds often smother the surrounding grass. Where the ants nest, grass roots may be destroyed. Ants also destroy grass seeds and may prevent good stands in seeded lawns.

Some ants are a nuisance because of their sting; fire and harvester ants are especially vicious.

CONTROL OF PESTS ATTACKING TURFGRASS.

Most insecticides recommended or used for control of pests' damage to lawns are known, or at least available, by Trade Names and the ingredients and percentages are given on the label. Also, specific directions for uses or applications are included on the labels. Since it is impractical to present details relative to dilutions and amounts per unit or area to be applied, dosages and instructions for use are omitted and only the chemical names are included. FOLLOW THE INSTRUCTIONS ON THE LABEL. Remember that practically all insecticides are poisonous and special care should be taken during application and that all pesticides should be stored in "Safe Places".

NAME OF PEST	RECOMMENDED INSECTICIDE
Southern (lawn) chinch bug	Carbophenothion (Trithion); Diazinon Ethion; V-C 13; Aspon; Dursban; Akton; Zytron; Baygon; Dyfonate
Bermudagrass mite	Sulfur; Carbophenothion; Diazinon; Ethion
Rhodes-grass scale	Diazinon; Malathion; Parathion
Leafhoppers	Malathion; Toxaphene; Diazinon; Chlordane; Carbaryl (Sevin); Dieldrin
Chiggers (Redbugs)	Dursban; Chlordane; Lindane; Sulfur; Toxaphene; Dieldrin
Earwigs	Chlordane; Carbaryl (Sevin); Dieldrin; Lindane; Baygon; Commercial Baits
Sod Webworm; Cutworms and Fall Armyworms	Carbaryl (Sevin); Chlordane; Dieldrin; Toxaphene; Dyfonate
White Grubs; Mole Crickets and "Common" Crickets	Aldrin; Heptachlor; Chlordane; Dieldrin; Dyfonate
Ants	Chlordane; Dieldrin; Mirex; Diazinon
Sowbug and Pillbug	Carbaryl (Sevin); Chlordane; Lindane; and Various Baits

UNIONS AND TEXAS TURF LABOR

Clifford Wagoner, Director
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Thank you for inviting me to speak today. Congratulations to your organization for seeing the need for education and doing something about it. I am honored to be a participant in this event.

This discussion will deal with experiences of others in turf maintenance industry, government agencies which enforce labor laws, statistics from labor analysis, and information taken from labor contracts.

In no way should this talk be taken as a testimonial for unions, or should it be considered as condemnation. My intention is to present a review from superintendents who have experienced attempts by unions to organize and have failed, where unions were successful in organizing, and where union agreements were in effect and have been cancelled. It is natural to assume all persons contacted were not in total agreement so will present the varied views of expression.

The first thing pointed out was the necessity of knowing and to be certain you are complying with state and federal labor laws. A question which always arises when discussing regulations is where do we fit in regard to interstate commerce? As per the representative of the United States Department of Labor in the wage and hour and public contracts division, any club or organization which has two persons or more engaged in either correspondence or receiving or shipping goods either manufactured or distributed from out of state, example cigarette, canned goods, or golf equipment is involved in interstate commerce and thereby comes under minimum wage and overtime laws. This information should be checked by each organization individually with a representative because the penalties and back pay regulations could be a very serious blow to the financial structure of a club. Also one other important item to check out is where state and federal laws regulate similar conditions the higher standard of the two being adhered to. Example child labor laws in California are more stringent than the federal, so the state over rules the federal in this case. The federal minimum wage is higher than California so the federal regulation will govern. In some instances you will be required to comply to federal in one section of overtime code and state in another. This sounds rather complicated but an interview with the local representative of state and federal agency which governs labor laws will be beneficial to help understand where you fit in. Undoubtedly representatives will not interpret the regulations the same, the reason I am not making any specific recommendations except to make this contact. A large number of pamphlets is available and can be obtained at no cost which will be of help if there is no office in your immediate area.

The reference to regulations governing minimum laws is primary in most instances because most superintendents to recruit employees and to retain them must pay considerable more than is required by the government agencies. The mere competition of industry forces this upon us. Areas will differ because of availability of employees and type employment offered whether it be government installation or private enterprise.

According to the Kiplinger Washington Letter, a report distributed private businessmen, quotes "The plain fact about wage raises is that no let up is in sight. Wages are about 7% over a year ago. By year end, probably 8%. And they are going up indefinitely... Shocking. But that's the prospect. This is not just union wages, it's union and non-union, the nation as a whole...the average of all lines, all levels of industry. Unions expect to do BETTER than average...maybe up as high as 9-10%." Furthermore they suggest you begin planning which to us means next budget time take this percentage into consideration. Also if you are non-union and are negotiating depending on your present scale this could easily amount to 30% increase.

Upon receipt of your invitation to participate on this program to discuss unions, I mailed out a questionnaire to a number of golf superintendents who have had experience with unions. The cooperating superintendents represent many years dealing with unions.

The questions and comments were as follows:

1. What method was used in organizing your labor?

   a. Maintenance crew was organized with clubhouse personnel.

   b. Union official contacted men secretly and called a meeting.

   c. Business agent contacted club.

   d. Union planted an employee who encouraged 1/3 of the crew to sign petition. National Labor Relation Board election was held and union won.

   e. Employees formed own union which later joined with other major union.

   f. Golf Course built in conjunction with subdivision and shops Union insisted golf course be in union with other employees. Unions are able to wine and dine employees and allowed to promote unions, but firms hands are tied by law. No attempt can be made to discourage employee from going union. If any attempt is made along these lines, employer faces unfair labor practices.

2. What union represents your employees?

   Motel, hotel and elevator operators

   Laborers

   Laborers and hod carriers

   Teamsters

   Hotel - restaurant employees and bartenders international

   Building and service employees

3. How long has your course been unionized.

   Range was from 30 years to 1. A new effort is underway in Northern California to organize courses.

4. What benefits do employees realize now that they did not receive before joining the union?

   Higher pay, more paid holidays, greater overtime pay, shorter week, retirement, guaranteed time and one-half for four hours each week, family paid hospitalization, sick leave, life insurance.

   A large number of clubs who were on monthly salary schedules were changed to hourly, consequently the employee loses time on rainy days. The only protection afforded employee is he must be notified before reporting in or receive 2 hours pay.

5. How much are union dues?

   Range from $5.00 to $10.00

   The amount of dues does not necessarily indicate the service and benefits which will be derived.

6. How much must an employee pay to join?

   Range from $15.00 to $100.00

   No two locals represented in the survey have the same initiation fee even though they are representative of the same union. Again the fee charged does not represent the amount of benefits.

7. Are you in favor or against unions? (Question to superintendents)

   The yes and noes were evenly divided.

   Two comments were made - one if employee-employer relations are good and salary and fringe benefits are equal to competitive industry union cannot do any good, the other, if the superintendent salary is low union negotiations tend to call this to club officials attention and the superintendent and crew will benefit.

8. Have unions complied with their agreements?

   Yes at almost every club. No comments on the two clubs who indicated problems.

9. Are they able to supply the club with skilled workers.

   No - This was a unanimous no as far as turf workers were concerned. Mechanics and equipment operators at some clubs.

10. Do unions have any training programs for turf workers?

    This was an obvious no since no attempt has been made to recruit workers.

11. At your club have the unions contributed to higher cost on maintenance other than salaries?

    The yeses outnumbered the noes. The reasons given were more record keeping, crew is not as flexible, if a man works at a job with higher classification a short time in a day he must be paid the higher rate for the full day.

    Only at one club were the employees restricted in regard to the task they could perform. If new construction is being done, greater restrictions are enforced.

12. Give salary range of crew.

    Monthly salary of greensmen from $450.00 to $490.00

    Hourly from $2.43 to $3.43

13. Are new employees required to join union and how soon?

    Yes in all cases, but time varied from 2 weeks to 30 calendar days, to 31 working days. In some contracts permits were given to students working part time and temporary summer help not required to join.

    Some clubs have agreed to withhold initiation fee from employees pay.

14. List fringe benefits and cost of each.

Vacation - 1 week for first year, 2 weeks for 1 to 10 years 3 weeks over 10 years

Sick leave - 3 to 6 days per year accumulative to 12 days

Hospitalization is provided employee and family at a cost to club of approximately $25.00 per month.

Retirement costs from 5 cents per hour to forty cents per hour. In almost every instance when unions appear on the scene the major selling point is greater fringe benefits, and with this comes a very definite increase in costs.

15. What do you predict future negotiations will bring forth?

All agreed shorter hours, higher pay would be the result of future negotiations. More elaborate fringe benefits and tighter restrictions on the crew in regard to jobs which they can perform is the predictions of some.

16. Are you on the bargaining committee when contracts are being negotiated?

A large percentage of superintendents are on the committee. Those who are not expressed the desire to be included and believed they should be.

17. What was the board of directors reaction to unions?

At most clubs the club officials are not receptive to unions because in their businesses in many cases they have had unpleasant experiences and at the club they are concerned with holding the line on expenses. At clubs where unions met with approval the reasons were it allowed the officials to increase employee salaries and improve working conditions. An increase in dues or greens fees was justified.

18. Have you experienced a strike at your club? If so, what was your source of labor?

At clubs where strikes were held club members and their families made up the work force. This does not violate union agreements. At one club the contract allowed work to be contracted at club discretion, so when employees struck the club engaged a contractor who furnished semi-skilled labor.

During union negotiations and especially when clubs do not favor unions vandalism seems to increase. Although it cannot be directly associated with union activities the fact this follows a pattern would seem to make one believe there was some connection. Threats of violence were made at one club and they were required to hire patrolmen to protect property.

The game of golf could be priced out of competition with other sports if unions impose the same wages on maintenance personnel that has been forced on the building trades. An electrician, plumber, etc. costs our club $12.00 per hour. This represents $6.00 per hour wages $2.00 per hour fringe benefits and 15% overhead and profit. The $8.00 per hour for wages and fringe benefits would in most instances double present salary expenses and at some clubs triple them.

Golf courses operated for profit forced into paying exorbitant labor costs will cease to exist because these costs will be reflected in the green fees whereas municipal owned courses usually are staffed with lower salary personnel and not expected in most cases to show a profit will have much lower fees.

Our only defense is to improve present working conditions, provide salaries equal to or a little better than the salaries of comparative trades, review the fringe benefits and bring them in line and offer a retirement plan.

Clubs which will not recognize the need and upgrade their personnel relations probably need unions and will soon get them.

If unions are necessary one organized particularly for turf maintenance employees would seem to be the logical answer. Even though this was done in California 30 years ago and became engulfed by a larger and stronger union it could succeed and operate to everyones benefit.

Management who has the knowledge of all the alternates will be better prepared to make decisions when it is confronted with labor problems. I urge you to avail yourself to all government agencies, others in your field, and industry who have information and have had experience.

THE EFFECTS OF HERBICIDE RESIDUES ON TURF

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The degree to which herbicide residues injure turf is related to three factors: the concentration of herbicide, the type of herbicide and the stage of growth of the turf.

Herbicide Concentration. The concentration of herbicide remaining in the soil at any given time is influenced by the amount of herbicide originally applied. For this reason, every effort should be made to minimize the rate of application. This can often be accomplished by the use of surfactants, by proper placement of the herbicide and by proper timing of the application. The old adage that an ounce of prevention is worth a pound of cure is a good creed to follow.

The concentration of herbicide which remains in the soil is also related to its resistance to the several factors which bring about its loss. The most important factors are photodecomposition, volatility, adsorption, leaching, chemical decomposition and microbial decomposition.

Photodecomposition occurs when light, usually in the ultraviolet region of the spectrum, reacts with the herbicide to produce a change in molecular structure. Soil incorporation essentially eliminates this process.

Volatilization occurs when a herbicide changes from a liquid or a solid to the gaseous state. The rate at which a herbicide volatilizes is related to its formulations and the temperature. Soil moisture also influences the volatility of many herbicides. Soil incorporation reduces volatility.

Adsorption occurs when a herbicide is reversibly bonded to the soil. The degree to which adsorption occurs depends upon the organic matter and clay content of the soil and the polarity of the herbicide. In most cases more herbicide is adsorbed to the soil than is present in the soil solution.

Leaching occurs when water moves a herbicide downward through the soil profile. In general, conditions which limit adsorption increase leaching. Thus herbicides leach most readily in sandy soils with low organic matter.

Chemical degradation is probably the least understood means by which herbicides are dissipated. For example, until recently the principal means of degrading the triazine herbicides was thought to be microorganisms. Now many researchers believe the triazines are chemically degraded via a process that is catalyzed by adsorption on to clay particles.

Microbial degradation is the most universal means of reducing the persistence of herbicides. To my knowledge, no organic chemical is completely resistant to microbial attack. The susceptibility of herbicides to microbial degradation varies considerably depending primarily on chemical composition and environmental conditions. Simplicity of chemical structure and warm, moist conditions usually favor rapid degradation.

Herbicide Type. In general, the greater the activity through the soil, the greater the danger of injury from residues. Many herbicides kill only by direct contact with the plant and have essentially no activity through the soil. Paraquat (1,1'-dimethyl-4,4'-bipyridinium ion) and DSMA (disodium methanearsonate) are chemicals commonly used in turf which are non-active through the soil. These chemicals are inactivated by adsorption to soil particles. It has been reported that soil can absorb approximately 0.3 milligram of paraquat per gram of soil. Assuming that an acre furrow slice of soil weighs 2 million pounds, the soil could absorb approximately 600 pounds per acre. Since paraquat is usually applied at rates of 0.5 to 1.0 pound per acre, it is apparent that there is little danger of paraquat toxicity through the soil. In fact, paraquat is used to kill the existing vegetation and more desirable plants are seeded immediately after spraying. Although DSMA is not as readily adsorbed by the soil as paraquat, many plants are not injured by concentrations of 50-100 pounds per acre in soil.

Herbicides such as 2,4-D [(2,4-dichlorophenoxy) acetic acid] and dicamba (3,6-dichloro-o-anisic acid) exhibit maximum activity when absorbed by plant leaves but they also have considerable activity in the soil. Both chemicals are susceptible to microbial degradation and it is unusual for phytotoxic concentrations to exist in the soil for more than 3 months. Dalapon (2,2-dichloropropionic acid), a herbicide which is not recommended for general turf use but which could be used to renovate lawns or golf greens, is active through the soil as well as through the foliage. Its persistence in the soil, however, is generally less than 1 month.

Many herbicides commonly used in turf exert essentially all of their phytotoxicity through the soil. Among these herbicides are bensulide [O,O-diisopropyl phosphorodithioate-S-ester with N-(2-mercaptoethyl) benzenesulfonamide] , DCPA (dimethyl tetrachloroterephthalate), benefin (N-butyl-N-ethyl-a,a,a,-trifluoro-2,6-dinitro-p-toluidine) and diphenamid (N,N-dimethyl-2,2-diphenylacetamide). Because of their activity, the possibility of injury from soil residues is maximized. All of these herbicides are capable of providing season-long weed control, but their persistence may be shortened or lengthened by environmental conditions.

Stage of Growth. The stage of growth is relatively unimportant in determining the response of turf to paraquat since paraquat is non-selective in its action. It is more important in determining the response of turf to 2,4-D and dicamba. Established grasses are tolerant of these chemicals but germinating seedlings may be stunted or killed. The stage of growth is paramount in determining the response to herbicide such as benefin or bensulide. These herbicides are decidely more effective against germinating seedlings than they are against mature plants. For this reason they should only be applied to established stands of turf. However, they are relatively ineffective against established weeds and should be applied before the weeds germinate.

ACCOMPLISHING THE WORK WITH LESS LABOR

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"Accomplishing the work with less labor" is the topic I would like to approach from three aspects; namely, (1) equipment, (2) chemicals and (3) efficiency.

First -- equipment. Having the proper type of equipment for a specific job is most essential when doing work on parks, cemeteries, golf courses, school grounds or other turf areas. For example; a reel mower is needed in an area of more formal nature or where a good smooth cut is desired, while a rotary or flail mower should be used in informal areas such as highway right-of-ways and some areas of golf courses and parks. Assuming we know the proper type of equipment needed, it is now our responsibility to select the correct size of equipment to perform a given job. With labor costs rising as they are today, it is our obligation to get the best job done for the least amount of money. There are very few of our superiors who won't listen to us when it comes to saving labor cost by purchasing the correct type and size of equipment. At this point, I think we should use the expression "put the pencil to it".

Example #1. Push mower versus riding rotary mower. One man on a large riding rotary mower costing $1200 can do the same amount of work as 3 men with 3 push mowers. Which is the most practical operation?

3 men @ 1.6-/hr = 4.80/hr

1 man @ 2.00/hr = 2.00/hr

2.80/hr saving in labor

1 riding rotary @ 1200 = 1200

3 push mower @ 125 = 375

$825 additional equipment cost

divide $2.80 into $825 = 294 hr

So, after 294 hours or 7 1/2 weeks or 2 months of operation, the riding rotary mower has paid for itself in labor saved. From that point on, you can prove to your superior that you are not only saving money but making him money.

Example #2. Walking greens mowers versus triplex greens mowers. On my particular course, it takes four men with trucksters about 2 1/2 hours or a total of ten man hours to mow 18 greens with walking greens mowers. In comparison, one man with the new triplex greensmower can do the same job, of equal quality, in a total of 3 hours. Now let's "put the pencil to it".

10 man hours @ 1.60/hr = $16.00

1 man (3 hr)@ 2.00/hr = 6.00

$10.00 saving every time greens are mowed

1 triplex greensmower @ 2800.00

4 walking greensmowers @ $500 each 2000.00

$ 800.00 added equipment expense

divide $10 into $800 = 80 times

So, after mowing greens 80 times or in 3 months you are saving money.

In these examples, transportation and operation costs were not mentioned, but certainly should be considered before making a decision to purchase. The main point to remember from these two examples is payroll savings had paid for the purchase of the more mechanized equipment. An additional savings is realized in that supervisory time may be concentrated on one person rather than being scattered between 3 or 4 men.

Let us now consider the maintenance of these pieces of equipment. You and I know with the push mower versus riding mower example that there are 3 engines versus 1 engine to maintain. Which engine do you think is going to be able to work 8 hours a day every day? We all know the one large engine will probably give less annual maintenance problems. Here again we have accomplished the work with less labor.

Since I have just brought up the subject of engines, I would like to make mention of something of which many of us are guilty. We are interested in purchasing a piece of equipment and we have it demonstrated, we examine it and do everything to it including "put the pencil to it". Let's assume it appears to be a wise investment from labor-saving standpoint, but guess what happens after we have used it for several hours. Yes, trouble with the engine has developed. We have purchased a piece of labor-saving equipment that now begins to cost money, both in down time and mechanic repair time. What we have just done is purchased a $1,000 machine with a $50 engine. I feel it is time for us as supervisors and operators to encourage heavier duty engines on our labor-saving equipment. What difference would it have made at the time of purchase if the machine would have cost another $50 to $100. Probably none.

The second point to consider is the chemical aspect. Here again with the rising cost of labor, it is imperative for us as managers to look into the use of chemicals as a means of accomplishing the work with less labor. For years we have had single purpose insecticides and fungicides that were proven best for good operations providing a preventative spraying program was followed. Now we are able to purchase better insecticides and fungicides that are broad spectrum in nature, therefore, we don't attack just one problem, but several. Also, there are now selective and broad spectrum herbicides, miticides, and nematicides which we should take a serious look at in getting our job done for less money. At this point, we should consider the pre-emergence and post-emergence chemicals along with systemic chemicals. Only you can determine their use and "putting the pencil to it" or by observing the aesthetic value they give.

For an example: A particular herbicide used at the proper time along with the proper management would be one that serves as a post emergence control on winter grasses and weeds in the late winter while bermudagrass is still dormant. I pick this timing because the weeds in dormant bermudagrass are reaching a point for the need of mowing.

Cost of material --- $6.00/acre

Labor to apply ----- 1.00/acre

$7.00/acre total cost

Labor costs of mowing fairways -- $.50/acre

Now we see it would take 14 mowings to pay for the material and the labor of application. This doesn't seem practical from a labor-saving standpoint but while the fairways weren't being mowed, a man was free to do other work or perhaps another man didn't have to be hired. This example illustrates that costs of the chemical and labor were justified mainly for aesthetic and not practical purposes.

Some of the things that were accomplished by the herbicide application were: First, Fairways didn't have to be mowed for 3 weeks; secondly, fairways remained solid golden brown without spots of green weeds, and third, and foremost, was that the bermudagrass came out of dormancy without competition for food, water and sunlight; therefore, it became green earlier than untreated areas. Taking all these points into consideration, the money spent in applying the herbicide was worth it.

Proper chemicals could be utilized to help perform those numerous "odd jobs" that we are so prone to post-pone or overlook. For instance, controlling of cattails, lily pads and algae in ponds, killing weeds in fence rows, around signs and trees, and using a selective herbicide to encourage the desired plants to grow.

My third and last point to cover is efficiency. There is no substitute for proper prior planning, be it in construction or day-to-day maintenance, we should draw up a set of objectives. This can be used as a presentation to our superiors for project approval along with serving as a "memory" and guide to us as the job progresses. Some points that should be covered in the objective are: WHERE WHY HOW WHEN and HOW MUCH. Evaluate the tentative plan of work against the actual work to see if you are keeping up with the time schedule and costs. Plan your work and work your plan.

This is not only applicable to major projects but also on things such as equipment repairs in the winter months. For example, get with your mechanic and establish an equipment repair schedule for all your machinery. This plan will enable your mechanic to plan his work, order parts and plan ahead of time and make necessary adjustments should unforeseen problems arise. With a schedule of this type, you are able to plan daily maintenance without the use of a certain piece of equipment that is in for repairs.

Most of us have ideas and plans in our minds for each day's work but our men don't know what they are, so written work schedules should be an important part of our day-to-day operations. Begin with ourselves by scheduling our work efficiently, then proceed to do the same for our men so they know what to do. We have found that posting the men's work schedule on a blackboard works very good.

After we have implemented our work schedule and objectives, we should be able to check the time it takes to do a job. Here is where a simple cost analysis or time and motion study should be done. Have the men fill out a form each day as to what they have done and the amount of time it has taken them to do the various jobs. We can take this information and study it to see how we can accomplish the job with less labor in the future.

Being able to communicate by radio between superintendent and assistants can certainly save a lot of time, energy and dollars. One can spend a lot of money for an elaborate radio system or can spend very little for a low-watt Citizens Band unit. Take your choice but look into your communication problem.

At this point, I would like to show some slides pertaining to what I have just talked about.

In summation, the equipment, chemical and efficiency can only be as good as the supervision and planning that goes into "accomplishing the work with less labor".

PLANT DISEASES ARE IMPORTANT

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Plant disease occurrence on turf assumes importance when it is not prevented. Too often we think of controlling turf diseases when they have reached epidemic proportions at which time satisfactory control is at best unlikely. One does not have to be in possession of a crystal ball to anticipate the occurrence of disease and plan a preventive control program. Micro- organisms that damage turf, respond to environmental factors like higher plants and animals. This seasonal occurrence serves as one tip for timely control action.

The possibility of a disease occurring for the first time is always with us; however, the greatest difficulty comes from those that occur year after year. If one becomes familiar with these diseases and understands the conditions required for the culprit organisms, he is well on his way to establishing a sound disease prevention program.

The fate of future turf disease control is reputed to be in the area of chemicals. In addition to effective materials now available, new and more effective materials are being developed. Their availability serves as a strong right arm to the golf course superintendent or others responsible for turf maintenance.

We all need to be reminded, however, not to lean altogether on "the chemical crutch". A chemical effectiveness is always improved when they are used in combination with good cultural and fertility practices.

Turf disease development in relation to fertility is a subject that always deserves consideration. In general, nitrogen levels above those required for balanced fertility increase the plants susceptibility to disease. Potassium, on the other hand, tends to decrease susceptibility when it is kept in balance with other nutrients.

There is a general tendency for us to ascribe one causal factor or condition to every problem of poor plant growth. Some problems do have simple solutions where the majority are more complex. Lukens (1) for example, studied a variety of conditions that favored melting-out on bluegrass that is caused by the fungus, Helminthosporium vagans. He found that excess nitrogen, low light intensities, close mowing and high moisture conditions all contributed to the development of this disease. These conditions result in poor food manufacture by the plant and predisposes it to this "low-sugar" disease.

New and newly-recognized diseases are always of interest. In 1967 McCoy, Toler, and Amador (2) discovered the occurrence of a malady on St. Augustinegrass that proved to be caused by a virus. This disease was subsequently named St. Augustine Decline (SAD). It has been found in twenty-six (26) Texas counties as far north as Fort Worth. This disease has been most destructive in the Corpus Christi area.

Another new disease was described by Jones and Amador (3) on St. Augustinegrass in 1969. It has been observed in Texas and Florida, but its importance as a destructive disease has not been fully determined.

Nematode damage on turf is a newly recognized problem in many areas. This damage has undoubtedly been present for many years, but has only recently been recognized. The Texas Agricultural Extension Service has begun a service of soil nematode analyses to be performed by the Plant Nematode Detection Laboratory. For a $2.00 service fee, soil samples will be analyzed for the presence of plant parasitic nematodes. Those in charge of the laboratory will furnish information on numbers of parasitic nematodes in the sample and give control recommendations if warranted. Samples should be submitted to the Plant Nematode Detection Laboratory, Texas Agricultural Extension Service, College Station, Texas 77843. Information sheets, soil sample bags, and shipping cartons may be obtained from any county Extension office.

Successful control of plant diseases is accessible to the person who is informed about their nature and occurrence. This information permits him to manipulate agronomic practices and use the right chemical, in the right way, and at the right time to achieve successful control.

References

1. Luhens, Raymond L., 1968, "Low Sugar Disease 'Melt-out' on Bluegrass", Turfgrass Times. Volume 3, No. 5.

2. McCoy, Norman, Robert W. Toler, and Jose Amador, 1969, "St. Augustine Decline (SAD) -- A Virus Disease of St. Augustinegrass", Plant Disease Reporter (In Press).

3. Jones, B. L. and Jose Amador, 1969, "Downy Mildew, A New Disease of St. Augustinegrass", Plant Disease Reporter. 53:852-854.

INFORMATION RELATED TO TURF DISEASE OCCURRENCE AND CONTROL 1/

Disease	Most Common Hosts *	Seasonal Occurrence	Chemicals Reported to Give Control
Helminthosporium leaf, crown and root rots	All	Warm or cool depending on host and phase of development	X X X X X X X X X X X X X X
Pythium Blight	B,Bnt,RG,FG,KBG	Cool (in South)	X X X X
Rhizoctonia Brown Patch	B,SA	Cool nights	X X X X X X X X X X X X X
Rhizoctonia Seedling Blight	Bnt,RG,FG,KBG	Cool soils	X X X X X X X X X X X
Rusts	B,SA,ZY	Mild, warm humid weather	X X X
Powdery Mildew	RG,F,KBG	Cool	X
Piricularia Leafspot	SA	Warm and humid	X X X X X X X X X X X
Fairy ring	All	Warm, damp soil	X
Curvularia Fading-Out	All	Warm	X X X X X X X
Nematodes	All	Warm	X X

Chemical ** Trade Names ***

Daconil One
Dasanit Dasanit
DBCP Fumazone, Nemagon
Dyrene Dyrene
Terrazole Koban
Mercury 2/ PMAS, Phenmad
Mercury 2/ Kroma-Clor
Mercury 2/ Calo-Clor or Calo-Cure
Mercury 2/ Panogen Turf Spray
Cyclohexeximide Actidione formulation
Captan Captan
Thiram Tersan 75, Kromad, Spotrete
Maneb Manzate 200
Maneb Fore, Dithane, M-45,
PCNB Terraclor

* B Bermudagrass; SA St. Augustine grass; Bnt Bentgrass; RG Ryegrass; F Fescue; KBG Kentucky; ZY Zoysia

** This chemical listing is not intended to be exhaustive and is given only as an indication of satisfactory performance against listed diseases.

*** The mention of trade names does not imply approval of these products to the exclusion of others that may be equally effective.

1/ The author acknowledges assistance of Norman L. McCoy and Jerral D. Johnson, Extension Plant Pathologists, in developing this information.

2/ Do not use mercury-type fungicides on bent grasses.

HOW DO PRE- AND POSTEMERGENCE HERBICIDES KILL WEEDS IN TURF[1]

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An understanding of the mode of action of herbicides is essential for proper management of weed problems in turf. Herbicides have specific ways to kill plants and move in the turf soil. A knowledge of the herbicide uptake by leaves and roots and their movement in the weeds helps one make good use of available herbicides.

The arrangement and classification of single herbicides and herbicide mixtures with and without fertilizer listed below will provide information about timing of treatments. Brief discussion is given about the known ways the herbicides kill weeds. A careful check is essential of the label for the chemical name of the herbicide, weeds controlled, and safety to turf species. Many trade names are assigned to the same chemical, or mixtures. Some chemicals may have 10-15 trade names.

Herbicide Classification

I. Contact herbicides - These chemicals kill primarily by contact with plant tissue rather than as a result of translocation.

A. Nonselective foliage contact - Herbicides in this class are toxic to plants generally without regard to species, turf grasses, or weeds.

Common name	Chemical name	Some formulations
Cacodylic acid	hydroxydimethyl-arsine oxide	Phytar 560, Scott Erase
Endothall	7-oxabicyclo [2.2.1] heptane-2,3-dicarboxylic acid	Endothal Weed Killer
Naphthas (Herbicidal oils)	refined petroleum fractions	Several
Paraquat	1,1'-dimethyl-4,4'-bipyridinium ion	Ortho-Paraquat

[1] Trade names included in this article are not intended as endorsement of the product of a specific manufacturer, nor is there any implication that any other formulation containing the same active chemical is not equally as effective. Trade names are included solely to aid readers of this publication in locating and identifying the herbicides recommended.

1. Cacodylic acid - This herbicide at 2 to 5 lb./A. plus .5% surfactant by volume is useful as a renovating treatment which kills all vegetation. Turf can be seeded after treatment. The chemical is also useful along ditchbanks, waste places and fences.

   The chemical penetrates the plant parts quickly, disrupts cells and contents leak into intercellular spaces. Perennial grasses and broadleaves will regrow from underground structures after treatment.

2. Endothall - Use surfactant .5% by volume with 3 to 4 lb./A. of endothall on young broadleaves and grasses in bentgrasses and bluegrass turf. Its best use is for winter annuals in dormant warm season turf. Do not use on red fescue turfs.

   There is no downward movement in the plants. Endothall is readily absorbed from the soil and translocated upward in the plants water stream. After postemergence application this chemical may also kill weeds germinating soon after initial postemergence kill. Endothall has direct contact toxicity on roots of young seedlings.

3. Naphthas - The herbicidal oils at .5 to 15 gal./A. are useful near fences, and edging, and young weeds in larger areas. The oils have properties similar to the waxes of the leaves and stems, and they penetrate plant parts quickly. The oils breakdown cell protoplasm which leads to the collapse of the leaf. The oil is incorporated into the plasma membrane of the plant cell.

4. Paraquat - at ½ to 1 lb./A. plus .5% surfactant by volume, paraquat is applied to dormant turf as a broadcast treatment. Spot treatment of fescue and ryegrass, and edging is effective with this chemical. Local systemic action has been noticed. Translocation via the xylem can occur under certain conditions. Light and oxygen are necessary for the bleaching action of green plants.

   Perennial grasses and broadleaves regrow from underground structures after treatment.

B. Selective translocated foliage applied herbicides with some contact action - These herbicides are more toxic to some plant species than others. Contact effects are evident on young seedlings or at high rates on older grasses and broadleaves.

Common and some trade names	Chemical name	Estimated number of formulations
Dalapon (Dowpon)	2,2-dichloropropionic acid	1
DSMA (Ansar 184, Scott Clout)	disodium methanearsonate	10
MAMA (Super Dal-E-Rad)	monoammonium methanearsonate	8
MSMA (Ansar 170, Daconate, Weed-E-Rad)	monosodium methanearsonate	5

1. MAMA, DSMA, and MSMA - These herbicides used at 5 to 8 lb./A. + .5% surfactant by volume control dallisgrass, crabgrass, carpetgrass, annual bluegrass, and goosegrass. Good control of nutsedge is obtained with these chemicals. Repeat treatments are necessary for reducing nutsedge population.

   Tolerant turfgrasses are bermudagrass, fescue, zoysia, and bluegrass. These herbicides are also effective around trees and in waste places for giant ragweed, cocklebur, and Johnsongrass control.

   These chemicals penetrate the leaf and moderate movement occurs in the plant. The chemical apparently disrupts the structure of the cell and causes its contents to leak into the intercellular spaces. The action is rapid and results are evident 4-5 days after treatment.

   Rate of application determines the degree of plant kill and the extent of translocation into underground structures of perennial weeds. The higher the rate the less is translocation.

2. Dalapon - Dalapon at 5-10 lb./A. + .5% surfactant by volume is effective on all grasses. In some cases bermudagrass and other renovations are needed. Dalapon sprayed broadcast will kill down these grasses. Planting or sodding can be done after residues are diminished.

II. Selective translocated foliage and root applied herbicides - this class of herbicides do not have contact action, but are moved within the plant from the root, stem, or leaves, and may exert a chronic action or gradual kill.

A. Hormone-type herbicides and mixtures with nonhormone-type

Because of spray drift, granular formulations are suggested. They are easy to spread and are formulated separate, mixed with either another herbicide to improve control, or the mixture with fertilizer.

The granular forms kill the germinating and very young weed seedings. Time the application accurately prior to weed emergence. Sprinkle irrigation, or rainfall improves the action of granular herbicides.

Common name	Chemical name	Some formulation
2,4-D	(2,4-dichlorophenoxy) acetic acid	amine and lithate salts and esters
Dicamba	3,6-dichloro-o-anisic acid	Banvel
Mecoprop	2- (4-chloro-o-tolyl)oxy propionic acid	Chipco turf herbicide MCPP, Cleays MCPP
Silvex	2-(2,4,5-trichlorophenoxy) propionic acid	Garlon, Kursal, Kuron
2,4,5-T	(2,4,5-trichlorophenoxy) acetic acid	Several

The following formulated mixes of hormone-type herbicides are available in most states for weed control in turf. Rates range from ½ to 3/4 lb./A. as a single treatment to 1 lb./A. total chemical in the mixtures.

1. Mixtures on fertilizer and estimated number products

a.	2,4-D	1
b.	2,4-D + dicamba	8
c.	2,4-D + silvex	2
d.	2,4-D + 2,4,5-T	1

2. Mixtures without fertilizer and estimated number products

a.	2,4-D + dicamba	2
b.	2,4-D + silvex	4
c.	2,4-D + mecoprop + arsonate	1
d.	2,4-D + silvex + arsonate	1

e. 2,4-D + either DSMA or MSMA 1

f. 2,4-D + mecoprop + DCPA + arsonate + insecticide 1

g. 2,4-D + chlorpropham 1

h. silvex + chlorpropham 1

3. Granular alone and estimated number of products

a. dicamba 4

The following hormone-type herbicide mixtures are formulated as liquids. Usually timing of granular formulations are not correct for best activity, and the liquid sprays for foliage application are selected. These sprays are for annual and perennial broadleaves in labeled turfgrasses. Mixtures are more efficient because of control of a broad weed spectrum.

1. Mixtures and estimated number of products

a. 2,4-D + dicamba 16

b. 2,4-D + mecoprop 3

c. 2,4-D + silvex 6

d. 2,4-D + 2,4,5-T 9

e. 2,4-D + silvex + 2,4,5-T 1

f. 2,4-D + either DSMA or MSMA 2

g. 2,4-D + dicamba + mecoprop 1

h. 2,4-D + endothall 1

The 2,4-D, 2,4,5-T, silvex, dicamba and mecoprop are formulated alone as liquids. St. Augustine and centipede are generally sensitive to 2,4-D, 2,4,5-T and silvex at rates needed for weed control, and bentgrass is sensitive to 2,4,5-T and silvex.

Mecoprop alone is useful in bentgrass and fine bermudas, bluegrass and fescue and their mixes.

The mixture of 2,4-D + mecoprop + dicamba is safe to St. Augustine and bentgrass.

The mixtures control many of the hard to kill broadleaves in turf.

B. Mode of action of hormone-type herbicides - The plant leaves absorb the ester formulations more readily than the salts.

In most cases, a rain-free period of 6-12 hours is required for effective weed control for the salts as foliage sprays, but the esters tend to resist washing from plants.

Following foliage absorption, the herbicides translocates within the phloem, probably moving with food materials. Following root absorption, they may move upward in the transpiration stream. Translocation is influenced by temperature (65-70° F night temperature required), moisture, and nutrient status of the plant.

Accumulation of the herbicide occurs principally at the meristematic regions of the shoot and root. Dicamba is active at these points by stimulating respiration.

If the concentration of the herbicides is too high it will destroy the living properties of the green leaf soon after application. Leaf penetration and translocation is essential for perennial weed control. The formative effects of 2,4-D, 2,4,5-T, silvex, mecoprop, and dicamba are similar. Certain low rates of dicamba and silvex under some conditions may impart similar leaf symptoms as weed control rates of dalapon and TCA.

Recent studies on 2,4-D foliage treatment to cocklebur, revealed death of the plant was due to suppression of normal top growth coupled with abnormal stem, and tap root growth. Failure to produce new growth and leaf tissue plus inadequate nutrients of roots and leaves lead to death. The plants showed abnormal nucleic acid metabolism.

The salts of hormone-type herbicides leach readily in sandy soil. Topical application may yield enough chemical in the soil to give some preemergence control after initial treatment.

Dicamba leaches readily in soil and should not be used under young trees, and shrubs. When controlling deep-rooted broadleaves in open turf, dicamba is a superior herbicide.

III. Selective herbicides soil application - The herbicides are applied pre-emergence to the weeds. They are sprayed or distributed on the surface of the turf or soil and activated by rainfall or sprinkle irrigation.

Granular formulations are suggested over liquids to prevent spray drift.

Common name	Chemical name	Some, and estimated formulation-number
Atrazine	2-chloro-4-ethylamino-6-(isopropylamino)-s-triazine	Attrex, Bonus Type S, 1
Bandane	polychlorodicyclopentadiene	Bandane-granular forms, 3
Benefin	N-buty-N-ethyl-a,a,a-trifluro-2,6-dinitro-p-toluidine	Balan-2.5% granular, 4
Bensulide	0,0-diisopropyl phosphorodithioate S-ester with N-(2-mercaptoethyl) benzenesulfonamide	Betasan-7% granular, 4 lb./gal. liquid, 6
DCPA	dimethyl tetrachloroterephthalate	Dacthal 2.5, or 5% granular or 75% wettable powder,22
Siduron	1-(2-methylcyclohexyl)-3-phenylurea	Tupersan, and 6 other granular, 1 wettable powder, 2 liquids
Terbutol	2,6-di-tert-butyl-p-tolyl methylcarbamate	Azar, 3 granular 1 wettable powder

1. Atrazine - This herbicide at 2 lb./A. + fertilizer is useful in newly sprigged St. Augustine, centipede and zoysia soon after planting.

   The chemical is absorbed by roots of seedling weeds. The seeds germinate in the chemical. It accumulates in the apical meristems and imparts a yellow, chlorotic symptom in the leaf margins.

   The chemical is an inhibitor of photosynthesis (food production) and may have additional effects. A gradual yellowing and death are typical symptoms of atrazine.

   Atrazine is adsorbed on soils and will leach in sandy soils.

2. Bandane - This chemical is a chloronated hydrocarbon used as a pre-emergence herbicide and as an insecticide. It can be used at 25-30 lb./A. after seeding or seedling and established turf for crabgrass control.

3. Benefin - At 2 to 3 lb./A. on established bluegrass, fescue, and ryegrass, benefin is effective for weed control. The bluegrass should be planted about 4 months before treatment and fine leaved fescue may be injured.

   Benefin is also suggested as a preplant treatment before the sprigging of bermudagrass, St. Augustine, and centipedegrass. Do not apply to newly sprigged areas of these same turfs because benefin will prevent root formations on stolons.

   The action of benefin is on germinating seed, and the developing plant roots. It does not leach in soils. The action of benefin on weeds as preplant before turf sprigging will reduce soil residues which will be safe to the grasses. On established stands of cool season grasses, root development is below the herbicide layer.

4. Bensulide - A herbicide which can be used at 10 to 20 lb./A. in bahia, bentgrass, bermudagrass, bluegrass, centipede, fescue, pensacola, perennial ryegrass, Poa trivialis, St. Augustine, red top and zoysia.

   Bensulide controls annual grasses and some broadleaves. It is not readily leached in the soil. The chemical prevents weed germination, and must be in the soil where the weeds are germinating. Bensulide is translocated from roots to shoots and stems of plants, and it affects the root system of susceptible plants.

5. DCPA - This chemical can be used at 8-10 lb./A. in new seeded grasses after greening appears or after runners begin on sodded turf. Do not use on bentgrass greens.

   DCPA is not absorbed by foliage. It is not translocated in the plant, but kills germinating seeds, exact mechanisms not yet known.

   Rate of 10-15 lb./A. are required for effective control of weeds.

6. Siduron - Available as wettable powder or granular on fertilizer + chlordane. Use 2 to 6 lb./A. for pre-emergence control of crabgrass, foxtail and barnyardgrass in newly seeded or established plantings of bluegrass, fescue, redtop, smooth brome, perennial ryegrass and orchardgrass, and bentgrasses - Penncross, Seaside, Highland, Astoria, Nimisila, C-1, C-7, and C-19.

   Do not use on bermudagrass. Will not control annual bluegrass, clover or most broadleaved weeds.

   Make treatment either as final operation after seeding, or in spring just before expected emergence of annual weed grasses.

   The chemical is absorbed through root system of young seedling, and translocated to leaves. The plant apparently dies because of lack of food production from photosynthesis.

7. Terbutol - This chemical at 10 to 12 lb./A. is safe on newly sprigged or established turf. It will not control spurge. Terbutol is absorbed through roots. Foliage application is not effective. It restricts terminal meristems. In grass seedlings, it prevents root growth and induces deformed leaves. It is not strongly adsorbed, but is slowly leachable in soil because of low water solubility.

   Weeds may be difficult to control in turf; but by proper selection of the herbicide for the weed, and timing application, and managing the system satisfactory weed control is possible.

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CHEMICAL APPLICATION THROUGH IRRIGATION SYSTEMS

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An irrigation system is designed to function as a dispensing system for water. Basically it is a distributive system and it should be capable also of distributing or spreading many of the chemicals, including fertilizer, used in turfgrass culture, and potentially, it is. Using the system for these purposes could represent a substantial cost saving: first, and most important, in reduced labor costs, and secondly, in savings in equipment purchase and maintenance. In addition, there is evidence from related fields - greenhouse culture of potted plants and flowers - to indicate, in the case of fertilizers, that small amounts of nutrients applied regularly through irrigation water produce plants displaying superior quality.

Despite these apparent benefits, it is most significant that to date, with very few exceptions, irrigation systems are not used for the purpose of applying chemicals on turfgrass areas. Why? Turfgrass managers are very astute and progressive and, in my opinion, not likely to overlook an opportunity to reduce costs and simultaneously improve turf quality.

To evaluate chemical application through an irrigation system, a number of factors must be considered. Among these factors are: (1) the many and varied soil and climatic conditions prevailing on turfgrass areas, especially on large facilities; (2) the physical and chemical properties of the materials - pesticides and fertilizers - needed to support and sustain high quality turfgrass; and (3) the mechanical capability and limitation of the system and of the devices required to place the chemical into the water line.

The key to effective use of the system as a vehicle for distribution of fertilizer and pesticides - fungicides, insecticides and herbicides - is the necessity for their uniform application and, in the case of fertilizers, at rates commensurate with the growth activity of the grass and use requirements of the facility.

Soil and Climatic Variation

Physical properties of soil have a direct bearing on uniformity of infiltration, percolation and drainage of water. In addition, topography (especially degree of slope), the degree of soil compaction and wind velocity, all influence the manner, amount and rates at which water will reach the root zone, even though the water may have been applied uniformly to the turfgrass surface. This variance in the rate of infiltration as a result of soil and climate variance is one of the major arguments against chemical application through the irrigation system. Uniformity of coverage is basic and will be discussed later.

Physical and Chemical Properties of Materials

Problems associated with solubility and the abrasive action of wettable powders may be eliminated by use of soluble compounds. The economics of such products may preclude their use in some cases. However, the fine particles of insoluble clay-type diluents found in wettable powders and the chemical impurities found in liquid and "soluble" materials make such a choice essential.

In certain situations fertilizer solutions may salt out. That is, some of the dissolved materials may crystalize and settle. The resulting sludge may clog controls and valves, and the composition and strength of the fertilizer would be altered.

Salting out is a temperature phenomenon and may occur (depending on the material and the strength of the solution) from 55 - 60° to well below zero. In general, the lower the temperature, the more likely salting out will occur.

Strength of solution is a controlling factor in the use of pesticides. With the exception of soil drenches and the possible exception of systemic compounds, the dilution rate of most pesticides would be too low to be effective. At the present time, therefore, these chemicals should not be considered for application through the irrigation system.

There is evidence to indicate that low rates of fertilizer - especially nitrogen - applied daily or at the time of irrigation are beneficial to uniform, healthy growth. This is the area which shows the most promise to date. Several golf course superintendents have installed devices that permit application of nitrogen through their irrigation system. They have proved effective and as uniform as the uniformity of water coverage.

The Irrigation System

A careful balance and adjustment of many complex factors are required to water landscaped areas properly. It is necessary to balance watering practices to fit soil conditions, to suit the demands of climate and to satisfy the physiological requirements of the plants - grass, trees, shrubs and flowers. All must be adjusted to conform to the requirements for the use of the area. Although basically similar in principle, there are complicating factors associated with proper and effective watering of small areas that are not always found on larger sites. For example, the complexity of landscape patterns or designs, space limitations, concentrations of plants with widely different water requirements and frequently, limited water supply, poor quality of water, inadequate pressure and poor or restrictive distributive systems, all influence watering of small areas.

Irrigation equipment presently available permits the controlled application of precise amounts of water. Further, such systems are capable of delivering the water in accordance with the needs of the grass plants and in conformance with the ability of a given soil to take in (infiltration capacity) and store water (water holding capacity). Most important, today's systems are economical and perform their functions in such a manner as to assure conservation of water and minimal operating cost.

The advances in controllers, valves and sprinkler heads that have occurred within the past few years have been substantial. These components, when used in accordance with a good design and when installed properly, perform effectively. It must be recognized, however, that any system, new or old, irrespective of how well it has been installed, used and maintained, is no better than its basic design.

To meet the need of an irrigation system for turf, and certainly for turf that will be fertilized through the system, good system design and therefore good performance have to start with the specifications laid down by the owner or his representative, preferably the turfgrass manager. He must know; then specify what he wants the system to do.

Basically, any system design is a compromise between cost and performance. Thus, the owner-operator-turfgrass manager must make certain basic decisions all of which revolve around obtaining the best performance for the initial cost and the operating cost he can afford to pay.

Design of a system to meet the need of turf starts with the operator's or turfgrass manager's answering questions such as: area to be covered, hours available for watering, amount of water to be applied, source of water, type of system, precipitation rate, wind velocity and service life of the equipment. Answers to these questions, once incorporated into a system design, are fixed and a change of mind at some later time will only result in dissatisfaction and headaches.

The area to be covered or watered must be determined and is probably best specified by use of an accurate plot plan. If this is laid out properly, there can be no question but that the system will meet the needs of the turfgrass.

On large areas like golf courses and parks, the hours available will have a marked influence on cost. For example, to water 100 acres at 1 1/2 inches per week would require a flow of 1590 gallons per minute if only 6 hours were available. However, if 12 hours were available, the flow would be reduced 795 gpm. The resulting saving from smaller size pipe pumps and valves would be substantial.

Wind condition is a frequently overlooked factor in design and performance. Unfortunately, many heads are spaced on a "no wind" basis. This is wrong. Note how spacing varies with wind velocity.

Miles per Hour Wind	Maximum Triangulator Spacing (Per Cent of Diameter)
1 - 3	70
3 - 5	60
5 - 7	50
8 - 10	40

The number of heads required for effective watering goes up in inverse proportion to the square of spacing. Therefore, three times as many heads would be required in an 8 to 10 mile per hour wind as are required in a 0 to 3 mile per hour wind. Substantial savings may be effected simply by the operator scheduling watering periods to coincide with periods of day or night when winds are low. However, if you are going to apply chemicals, design for them. Failure to specify the basic requirements for a given system has often been a source of difficulty.

Other considerations affecting the design of a system to be used for application of chemicals on turfgrass are those related to the component parts of the system. Among these are: specially designed 2-speed heads, use of non-metallic components like delrin, cycolac and puc; individual head control with a valve under or in each head; central and satellite control; combinations that permit recycling and proper nozzle selection. Injectors or metering devices, that place the correct amount of chemical into the irrigation system, are another important consideration.

THE MERITS OF SOIL TESTING, TISSUE TESTING AND PLANT ANALYSIS

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Scientific techniques for diagnosing plant nutrition problems and for evaluating responses are being perfected and developed at a rapid rate. This discussion is designed to point out some of the recent developments in turfgrass nutrition and means whereby the turfgrass manager can more effectively predict and control the nutritional status of his turf.

Why is plant nutrition important to the turfgrass manager? It affects turf in several ways: (1) growth rate and total growth, (2) the general health and appearance, (3) disease resistance, (4) drought and cold tolerance, (5) durability, (6) esthetic values.

Several techniques are used in diagnosing plant nutrition problems and forecasting nutritional needs for turf:

(1) Nutrient deficiency symptoms

(2) Plant growth characteristics

(3) Soil testing

(4) Field tissue testing

(5) Laboratory plant analysis

1. Deficiency symptoms

There are fairly definite symptoms associated with most nutrient deficiencies. These symptoms are given in publications dealing with fertilizer use and plant nutrition, such as Hunger Signs in Crops. There are several disadvantages in basing fertilizer needs and applications on deficiency symptoms: (1) by the time the symptom appears, the plant has already suffered, (2) the symptoms may not be sufficiently evident to be adequately diagnosed, (3) symptoms of one nutrient deficiency may be disguised by other nutrient deficiencies, (4) the nutrient in the greatest deficiency may show symptoms first. Other nutrients may also be deficient.

2. Plant growth characteristics also have many of the inadequacies which deficiency symptoms have. An additional disadvantage is that plants may never reach satisfactory levels of growth, if this "trial and error" method is used.

3. Soil tests are used to estimate fertilizer and limestone needs. A soil test comprises three major activities: (1) taking the sample, (2) making the chemical analysis, and (3) interpreting the test and making fertilizer recommendations. Each sample should be representative of the soil conditions from which it was taken. Several subsample or "cores" should be combined, thoroughly mixed, and compose one sample. A sample from greens should be separate from fairways, etc.

Chemical determinations are made for each of the nutrients reported. The Extension soil testing laboratory reports nitrogen, phosphorus, potassium, calcium, magnesium and soluble salts. The soil pH or (soil acidity) is also reported. The reports of these chemical tests do not show the total amount, but that amount is proportionate to what is available to plants. The soil test values have been related to the amount of nutrients needed for the desired growth.

Recommendations reported on soil tests are correlated with fertility experiments, and are made according to the desired production of the turfgrass manager. Enclosures are attached to the soil test to explain the test, fertilization, and liming practices recommended.

Soil tests are the foundation for a sound turfgrass nutrition program.

4. Tissue testing or field testing is a good tool to supplement a soil test. It constitutes very simple chemical tests of living plant material. Equipment is simple and can be carried to the field in a kit. In the hands of one trained in soil chemistry and plant nutrition, a tissue test made in the field can be a big help in diagnosing deficiencies of N, P, and K.

Tissue testing and field diagnosing also can be useful in locating hidden and borderline deficiencies which have not yet shown up in appearance. Field testing can also include examination of the soil profile to discover hardpan or restrictive layers, poor drainage, loss of fertilizer by denitrification, and other conditions not readily visible from a laboratory analysis.

5. Laboratory plant analyses provide accurate information on the nutrient composition of plants, and can supplement soil and tissue tests. The development of new analytical instruments has made diagnosis faster and more accurate. Plant analysis involves much more complex and accurate analysis than field tissue testing. It is performed in a laboratory equipped with complex, precise instruments operated by trained scientists. The plant analyses technique can give an accurate reading of major, minor, and micronutrients.

Plants often have hidden hungers. Plants may look healthy and may seem to grow satisfactorily while actually suffering from some elemental shortage. Secondary and micronutrients are used in smaller amounts than N, P, and K. The micronutrients are reported in parts per million. Thus, plant analysis may determine hidden hunger before the manager suspects a deficiency.

Plant analysis determines which elements are being taken up and used by plants, and what deficiencies exist. Plant analysis can also show a luxury consumption of a nutrient element or the substitution of one element or another.

Interpretations of plant analyses is a new science and involves a great many variable including the fact that a deficiency in one element may cause an excess in another. Such variation causes interpretations to be extremely complex. A plant analysis should be preceeded by a soil sample to indicate what nutrients are available in the soil. Plant analysis may partially solve some problems which are not completely explained by present scientific knowledge. They should not however, be thought of as a "cure-all" for all fertility problems. Certain other factors mentioned above may inhibit plant growth, yet a plant analysis may not discover such problems.

Analytical instruments used to determine micronutrient contents have just been developed in recent years and represent considerable investments. The cost of such instrumentation ranges from $10,000 to $70,000. Plant analysis will be an increasingly important tool aiding in fertilizer needs, providing the proper plant nutrients, and aiding the turfgrass management to obtain greater satisfaction from his fertilization program.

TRAINING PROGRAM FOR NEW EMPLOYEES

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We are all employees of some sort, either employed by taxpayers, club membership, an organization or a private individual.

Let's first make a comparison of our turf industry with one, we all know. Since it's fall, football is in the air and the main talk of everyone.

Comparison of Dallas Cowboys and Golf Course Superintendents:

$ (MONEY)	Paying Participance
Coach	Superintendent
Staff	Green's Committee
Quarterback	Asst. Superintendent
Halfback	Gang Mowers
Halfback	Tees Mowers
Fullback	Greens Mowers

The team is all Pro which means they are paid specialists, doing a special job to the best of their ability.

Our all Pro team just didn't happen but the coach and staff worked up the team through time and training. To make a winning team of this group takes a professional coach that brings out the best of each man. He must work year round, bring new ideas and material to the team so that when the season comes around, the Pro team is ready and hopefully a winning team.

Let's look at our professional superintendent and how he plans his attack on the opposition. In our case, the golf course, the growing and maintaining turf on it to the best of his ability.

He must also properly train his team to be specialists in their position. There are a number of ways to do the same, but let's try to outline one way.

I. Quality of the man

   A. Common-sense

   B. Pride in his work

   C. Ability to think

D. Willing to learn

E. Mechanically inclined

II. Proper training

A. "Show him" - instruction of proper operation of unit

B. Assign unit to each man

C. Allow man to have and read manual. "To Know His Unit"

D. Train him to "Look for the Unusual"

E. Train him to "Listen for the Unusual"

F. Teach him the capacity of the unit

1. Slopes

2. Type of unit

3. Speed

4. R.P.M. of engine

5. Etc.

III. Back the man with the BEST equipment and repair

A. Give him the most modern and best equipment available

B. Back him with proper repair of equipment (Stock repair parts)

C. Listen to him on equipment

To summarize:

Our team's training program.

In words of John F. Kennedy: "Ask not what your country can do for you--ask what you can do for your country."

In other words: "Ask not what's in it for you--but what you can do for your team and employer."

IMPORTANCE OF SOIL pH AND HOW TO REGULATE IT

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The degree of acidity or alkalinity of a soil can be expressed on a numerical scale of 0 to 14 known as a pH scale. The term pH refers specifically to the concentration of hydrogen ions in a solution. pH values of a soil therefore can be used to indicate the degree of acidity according to the following scale.

pH Value	Soil rating of acidity or alkalinity
4.5 or less	Extremely acid
4.6 - 5.0	Very strongly acid
5.1 - 5.5	Strongly acid
5.6 - 6.0	Medium acid
6.1 - 6.5	Slightly acid
6.6 - 7.3	Neutral (Specifically pH 7.0 only is neutral)
7.4 - 7.8	Mildly alkaline
7.9 - 8.3	Moderately alkaline
8.4 - 9.0	Strongly alkaline
9.1 and above	Very strongly alkaline

The most desirable soil pH range for most plants is about 6.0 to 7.0. However, most plants can grow very well in a wider range of pH 5.7 to 8.0 especially grasses. Certain horticultural plants such as azalea and Phododendron prefer a very acid range around pH 5. to 5.5.

Although the amount of hydrogen ion in solution is the direct measure of acidity or alkalinity, it is itself not the most detrimental factor usually associated with acid soils. As the acidity increases and the pH drops below about 5.5, some soil minerals begin to dissolve and allow manganese and aluminum ions to come into solution. As the pH drops further below 5.0, much larger amounts of these detrimental ions become soluble. Manganese and aluminum compounds can be dissolved in very acid soils to such an extent that they become toxic to plants and prevent satisfactory growth and even death of the plants.

Soil acidity is neutralized by the application of agricultural limestone which is calcium carbonate. On those soils which are also low in magnesium, a dolomitic limestone which contains both calcium and magnesium carbonates is recommended. Most of the acid soils in Texas occur in the eastern third of the state. In this area, soil acidity develops rapidly where heavy applications of an ammonium form of nitrogen (including urea) are used. Frequent soil tests are suggested in order to keep up with changes in the acidity and fertility levels of the soil. Information sheets and mailing cartons can be obtained from the county agricultural agent's office in each county.

Most of the soils in Texas are not acid but are neutral to alkaline particularly in the central and western part of the state. Iron deficiencies may become evident on these soils by the appearance of chlorosis or yellowing of the leaves even though sufficient nitrogen has been applied. The question is often asked if these soils can be treated to make them acid so that iron in the soil will be available to the plants. Treatment of soils with sulfur to reduce alkalinity on a large scale has not proven to be feasible or practical because of the tremendous amounts that would be required. The alternative of supplying a soluble or chelated iron material to the soil will produce more rapid and satisfactory results. For more information on iron deficiencies, refer to Leaflet L-435, Iron Chlorosis and Leaflet L-723, Identifying and Correcting Iron Deficiency in Field Crops.

MAINTENANCE OF AN IRRIGATION SYSTEM

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The irrigation system can be compared to the human body and the anatomy of the irrigation system should be known thoroughly for proper maintenance. Many of you have degrees in irrigation maintenance and this will be "old hat" to you but a review or check up occasionally does not hurt so as to be sharp on all aspects of repair.

To start with, the main pulse or heart of the system has to be the pump and motor. This brings us to the first maintenance rule of the pump and that is to be sure your screen is adequate to prevent sticks and refuse being sucked into the pump. A good screen will prevent clogging or wearing the impeller unduly as it is the heart of the pump, if it is the impeller type but regardless of the kind of pump, clean water is a necessity.

The impeller needs a rugged shaft to hold it in precisely the right position, but that ruggedness does not protect the shaft from the corrosive or abrasive effects of the liquid pumped so it is protected with sleeves slid on from either end. Never pump a liquid for which the pump was not designed. The shaft is mounted on sleeves or ball or roller bearings and the clearances between the moving parts of the pump are quite small. If bearings supporting the turning shaft and impeller are allowed to wear excessively and lower the turning units within a pump's closely fitted mechanism, the life and efficiency of that pump will be seriously threatened. So, we have to keep the proper amount of the right lubricant in the bearings at all times. Follow the manufacturer's lubrication instructions to the letter. Some of the main points to keep in mind are:

1. Although too much oil will not harm the sleeve type bearing, too much grease in anti-friction bearings will promote friction. The main job of grease in anti-friction bearings is to protect steel elements against corrosion, not friction.

2. The frequency of changing lubricant will not fit all pumps and it should be changed before it is too worn or too dirty.

3. The pump and motor flanges should be paralled vertically and axially and should be kept that way. Checking alignment should be regular procedure in pump maintenance as the foundation can settle unevenly, piping can change pump position, and bolts can loosen. Misalignment is a major cause of pump and coupling wear. Never allow a pump to run dry from lack of proper priming when starting or through loss of suction when operating. Water acts as a lubricant between rings and impeller. Examine wearing of rings at regular intervals.

Now that you have kept the pump in top operating condition, you have the sprinkler system to manage and periodic maintenance is necessary to take full advantage of the benefits available from an automatic system. The manual system has less apparatus to go wrong than an automatic. The automatic has ma-y component parts to be checked to keep in good running condition.

There should be a complete blueprint of the irrigation system and there is no doubt that the manager of the golf course should be present during installation for knowledge of every "joint" in the system.

There should be a small inventory of component parts for use in routine repair and the company representative can be a help in starting an inventory. This is the beginning of a good maintenance program. The inventory can include internal mechanisms for sprinkler heads, extra valve components, extra nozzles, and sprinkler caps. Irrigation companies feel clock components rather than clock elements should be stocked for controllers because malfunctioning components can be returned for repair. A few hundred dollars worth of inventory will provide a very adequate stock to service a sprinkler system. This is the same as having money in the bank for emergencies.

You should set up regular routine maintenance about equal to the daily checking of the golf course turfgrass. Many managers find it is best to operate the system a few minutes everyday. If the system is idle for a few days and then is operated, there will invariably be some malfunction.

The entire crew can be used for spotting improper working heads, such as those stuck in the up position, malfunctioning clocks, cracked pipes and valves not working. Most items can be repaired by the golf course crew and in some cases a specialist can be brought in and the knowledge and abilities of these people should be taken advantage of. It will take constant training but employees of the golf course can be motivated into checking for malfunctioning system parts.

If you have had an irrigation system for a year, you know the most frequent items requiring maintenance are the sprinkler heads. In most cases, the heads have been damaged by equipment of some sort, the mowing equipment in most cases.

Heads are seen stuck up on new courses more often than on well turfed courses but they can be flushed out readily to remove soil or sand. This is one of the most common problems in pop-up sprinkler systems; however, good maintenance practices can reduce this problem.

Winterization of an irrigation system is not too common in Texas except in the extreme northern portion of the state but there are some procedures to be considered. If you have a compressor, blow out the lines or be sure adequate drainage is available in lower areas so the system can be drained; however, compressed air will empty the pipes faster. In some areas where winter is severe, removing the heads and plugging the pipes prevents any water from the surface draining into the lines during the winter.

The manual operated or quick coupler system can be drained and the heads mulched or covered if weather is severe. It is doubtful that many systems in Texas receive any protection other than draining the water.

When water is needed in the spring, you will find out if any water was left in the system and frozen by the number of broken pipes throughout the golf course which spring leaks. A complete inspection of the system should be made, checking all heads and for leaks in the lines. Electric clocks should be checked including voltage as we have seen where voltage has been half the required amount. A complete shake down of the system should be made. Be sure the suction pipe is free of debris and clean water is a must to reduce maintenance problems. Your mechanic keeps equipment in excellent operating condition and we feel the same applies to the irrigation system. More routine maintenance should be considered necessary and be sure adequate spare parts are on inventory.*

* Reference, Dr. James Watson, Toro Manufacturing Company

MANAGER'S ROLE IN INSTALLATION OF AN AUTOMATIC IRRIGATION SYSTEM

Jim Holub, Superintendent
River Oaks Country Club
Houston, Texas

The River Oaks Country Club members have been interested in going automatic for some time but felt that something had to be done to the fairways first and then go automatic.

In July of 1968, the golf course architect submitted a plan to rebuild all the greens, reshape fairways and tees, also included was an automatic water system. Because of the trees and the clubs desire to water into the roughs a 2-row system was designed capable of putting 1 1/2 inches of water per week. The plan called for using our main castiron lines that were installed in 1958 and lateraling off using ring-type PVC pipe, blocking at 90° bends and at the end of each sprinkler with concrete as a trust block as this is the only means of holding the ring-type pipe from coming apart. Some glue joints were used when we had to return to threaded pipe. Each valve is installed with a galvanized union in the event that it may have to be replaced.

We used an electric solenoid-type valve to operate 2 sprinklers for the most part and 3 row in several fairways at a time. Each sprinkler is capable of putting out 45 gallons per minute at 75 lbs. pressure. Our same pumps were used, only difference was dropping the pump pressure from 150 to 120 lbs.

There will be 2 of the 6 panels on at a time and the amount of water called for will be about 750 gallons per minute. We have installed 445 sprinklers throughout the course.

The first fairways were planted in September, 1968; our responsibility after planting according to the contract was to water the stolons and keep them moist. Now this becomes a problem in that the valves were not able to operate electrically and would not for another four months.

There are several ways that the valve could be operated; one was to put a bleed-off on top of the diaphragm and by opening it the water used to close the valve would be allowed to escape, thus allowing the valve to open. Problem there was a man had to put his hand into 12" to 18" of water and in the winter this wasn't very agreeable. So we tried another method. This time we taped the diaphragm and put a screw in it; we also had to take the plunger out of the solenoid. Now the valve can be operated with a 7/16 socket on a long steel rod. We used this method on both of our 9 holes.

No matter the type of plan you have there are changes that have to be made. I have placed extra sprinklers in several fairways because the need was obviously in the field and not on paper. I also changed the type of sprinklers called for on the tees because we wanted more coverage.

One thing the plan did not call for was central controls. I had to have the controls in a central location. Our system has one wire for every valve coming directly to the central control panel next to my office.

I previously had looked at some central control units and thought to add to it by putting another panel directly under the main control unit. Each control unit has 4 stations and is an 11 station controller by our adding this extra panel with 44 switches. I can control each valve without interfering with the main unit.

For instance, to water the front of a green manually, I merely have to put the switch in down position; to stop a particular valve, I put the switch in neutral or to put it back on control, just put it in up position.

This extra panel cost about $100.00 each.

In my roll as manager or superintendent, all I could do was check on installations as to size of wire and pipe and placement of sprinklers. In addition to the system I asked for 2" lines extending into the roughs that I know will be used at a later date.

How much water to put on is a problem. When the fairways and greens are first planted, considerable amounts of water are needed. I remember one time I had the sprinklers on for 20 minutes, and recycled to water again that same night. Now that grass has been established, fairways are watered 2 to 3 times a week.

I have fertilized fairways late this fall trying to push the 419 bermuda as long as the weather will permit. We are using the 2.5 minute cycle for frost control to wash off the frost.

I found the automatic sprinklers are helpful in watering the overseeded greens as the amount of water can be controlled.

Watering at night has become quite a labor problem and I am sure more clubs will go to automation. I am pleased that we did.

WHAT IS INVOLVED IN FERTILIZING GRASS?

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Apart from irrigation during dry weather, fertilization influences turfgrass quality more than anything the turf superintendent does.

Knowing when and how much of a specific fertilizer to apply is the key. Proper fertilization will improve the appearance of any turf. Proper fertilization will also increase the longevity, decrease weeds, reduce diseases, and improve wear resistance of turf.

The wise superintendent follows a definite plan in providing turf with adequate fertilizer. A well-defined plan will take the guess work out of your fertilizer program.

What should be considered in developing a plan for year long feeding of turf areas? The most important factors to consider in determining how much fertilizer to apply are:

1. The grass species being used -
2. Climate and general soils of the area -
3. Amount of traffic expected -
4. Quality of turf desired and specific use -
5. Your equipment for controlling thatch build up -

What Nutrients Do Turfgrasses Need?

Turfgrasses need the same nutrients as other plants for good growth, but they require them in much different amounts. How do we know this? By chemical analysis of turf clipping we have determined what grass "prefers". In Table 1 you can see that turf clippings contain more nitrogen (N), potassium and phosphorus, but slightly less calcium, magnesium and sodium than other plants.

Table 1. Average Mineral Composition of turf clippings from a putting green compared to other plants.

Minerals	All Plants 1/	Putting Green Clippings
K	1.47	2.5
Na	.37	0.20
Ca	0.77	0.50
Mg	0.30	0.25
P	0.22	0.30
N	1.52	4.5

1/ Cooper et al. Soil Sci. Soc. Amer. Proc. 12:359, 1947.

Turfgrass researchers have shown that the nutrient most responsible for stimulating grass to grow is nitrogen. However, nitrogen alone will not do the job--other nutrients must be present in needed amounts if the grass is to be vigorous and healthy.

Analysis of turf clippings from many experiments across the nation show that turf grasses contain nitrogen, phosphorus (P_2O_5) and potash (K_2O) in a ratio of about 4 - 1 - 2, respectively. One such analysis is shown in Table 2.

Thus, in recent years many companies manufacturing turf fertilizers strive to compound a product that has 4 parts nitrogen for every 1 part phosphorus (P_2O_5) and 2 parts potassium (K_2O). An example is the many very popular brands of 12 - 4 - 8.

Table 2. Nutrients removed in bermudagrass turf clippings per 1000 sq. ft. annually 1/

From Air and Water	Carbon Hydrogen Oxygen	Over 80% of dry matter
Primary	Nitrogen	10.8
	Phosphorus	1.0
	Potassium	3.8
	Calcium	1.5
	Magnesium	0.5
	Sulfur	1.0
Minor or Trace	Iron	0.2
	Manganese	0.2
	Cu,Zn,B,Mo,Cl	Trace

1/ Prichett - U.F.

Any turf manager will tell you however, that nothing "turns grass on" like nitrogen. Research with St. Augustinegrass by Smalley at the University of Florida (Table 3) shows this to be true. Among the 16 nutrients essential for plant growth he found nitrogen affected growth of the St. Augustine most.

Table 3. Influence of mineral nutrition on the clipping yield of St. Augustinegrass. 1/

Nutrient Deleted					Check
-N	-Ca	-P	-K	-Mg	Complete
7.7*	8.87	10.7	12.8	14.4	19.5

* Weight in grams per plant 108 days after sprigging.

1/ After Smalley's data. University of Florida

One reason for this is that nitrogen is a basic component of many "key" compounds in the plant. Chief of which is chlorophyll, the green pigment which functions in photosynthesis. It is rich in nitrogen--thus plants starved for N turn yellow and grow very slowly. In this condition they are very susceptible to disease and withstand very little traffic.

Turfgrasses Vary in Nutrient Needs:

As may be seen in Table 4, turfgrasses differ in their needs for plant food. The bermudagrasses require more plant food than other warm season grasses. Not only does bermudagrass need more plant food than say, Zoysiagrass, but certain varieties of bermudagrass need more fertilizer than others. For instance, in our turf plots, the increasingly popular "No-Mow" bermudagrass performs as well on 4 lbs. of N annually 1/ as on 6 or 8. Adjacent plots of "Tifgreen" (328) and "Tifway" (419) did much better at the higher rates.

Care must be exercised in timing the application of fertilizers especially nitrogen to the various turfgrasses. A cool season grass, like bentgrass, for example, grows mostly in the spring and early fall. Even if moderate amounts of nitrogen are applied to these grasses in the hot summer months, they may be seriously damaged. Figures 1 and 2 show the nitrogen needs of bentgrass and bermudagrass when used for putting greens. Bermudagrass thrives on a summer nitrogen diet that would cause bentgrass to die out. Conversely applying large amounts of nitrogen to bermudagrass in the fall stimulates it to grow too rapidly. This produces large amounts of watery tissue which is highly subject to "winter-kill".

Fig. 1.

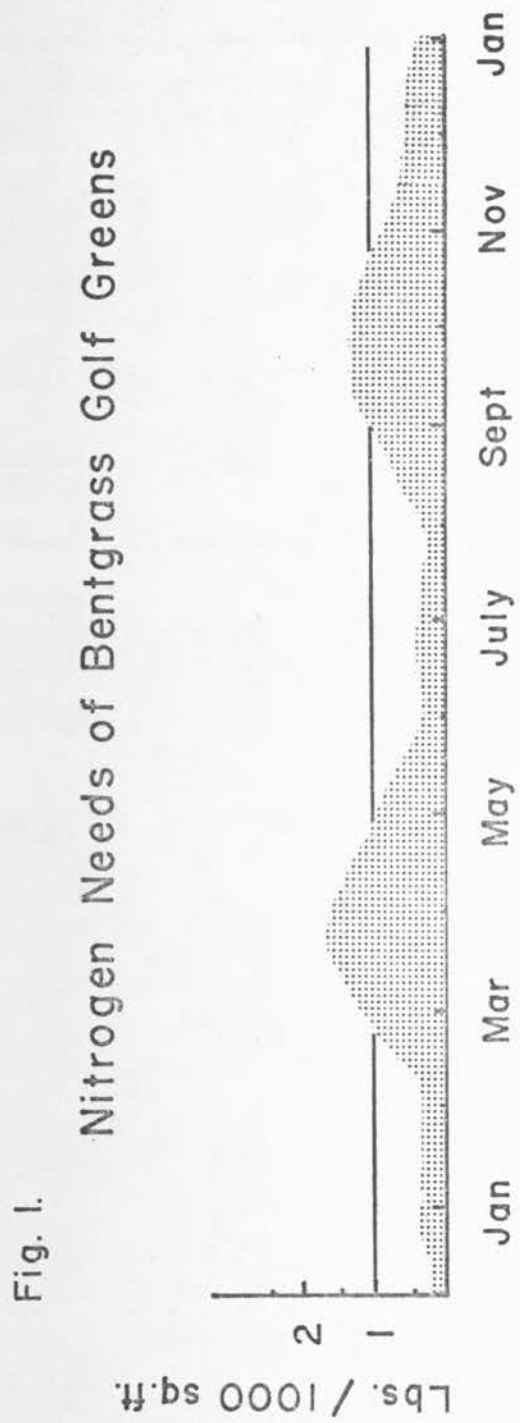
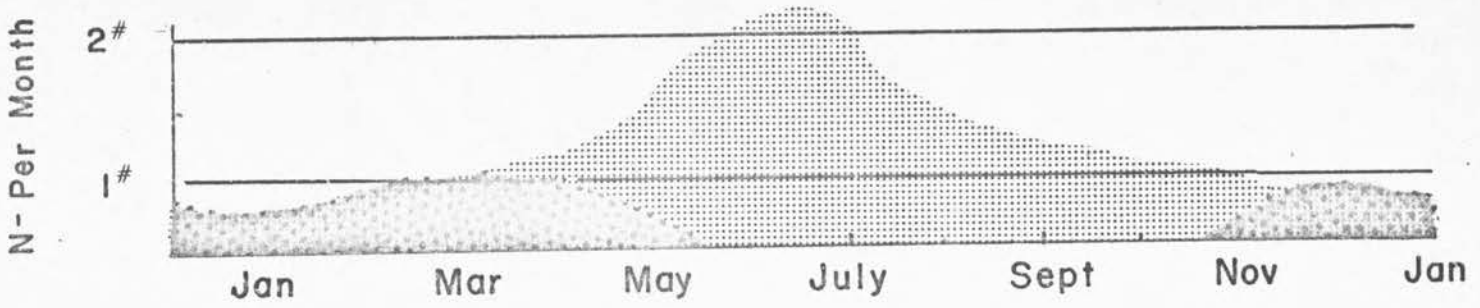

Nitrogen Needs of Bentgrass Golf Greens
Lbs. / 1000 sq.ft.
2
1
Jan
Mar
May
July
Sept
Nov
Jan
(8 - 10 pounds for season)

Fig. 2.

When to Apply Fertilizer?

Bermudagrass Greens



(16 to 18 pounds total)

Table 4. Nitrogen needs of turfgrasses used in the southern United States.

Species	Pounds of N per 1000 sq. ft. annually [1]			
	Lawns	Tees & Stacks Athletic Fields	Putting Greens	Roadsides
Bahiagrass (*Paspalum notatum*)	4-5	NR[2]	NR	2
Bentgrass (*Agrostis palustris*)	NR	NR	10	NR
Bermudagrass (*Cynodon Spp.*)	6-8	8-10	16-24	2
Centipedegrass (*Eremochloa euphiuroides*)	1-3	NR	NR	1
Fescue, Tall (*Festuca arundinacea*)	3-6	NR	NR	1-2
St. Augustine (*Stenotaphrum secundatum*)	4-6	NR	NR	NR
Zoysiagrass (*Zoysia spp.*)	5-6	NR	NR	NR

[1] P, K, and lime needed should be based on soil test made on a regular schedule.

[2] NR means the grass is not recommended for the use indicated.

Over-stimulation of grass plants during stress periods should be avoided. One way to improve the ability of turf to withstand stress periods is to provide a good balance of nutrients. Adequate potassium along with nitrogen reduces low temperature injury and is believed to harden the turf against other environmental stresses. As may be seen in Table 5, applying potassium along with the nitrogen in the fall gave Tifdwarf and Tifgreen bermudagrasses added cold tolerance. These grasses withstood 17° F. with adequate potassium, but were killed at 24° F. when only nitrogen was applied. A soil test will indicate the need your soils have for potassium.

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[1] Unless otherwise indicated, the rates of fertilizer nutrients or materials indicated are for 1000 sq. of turf.

Table 5. Effect of N-P-K nutrient balance on cold tolerance of bermudagrass 1/

Ratio N-P-K	Low temperature in killing point °F	
	Tifdwarf	Tifgreen
4-0-0	24	23
4-0-2	23	21
4-1-0	23	22
4-1-2	17	20
4-1-5	17	17
4-5-1	21	19

1/ Data from dissertation of D. L. Davis, North Carolina State University, Raleigh.

Climate and Soil Affect Fertilizer Needs of Turf

As a rule, most soils in the Southern U.S. are low in N, P, K, and Calcium. However, in general, soils in areas receiving less than 30" of rainfall annually are well supplied with calcium and potassium. Except on highly modified soil areas such as golf putting greens the need for lime and potash in these drier regions is nil.

Soil Test To Be Sure:

To be sure of the fertility status of your soils, send a sample of the soil to a "Soils Testing Laboratory". Texas A&M University and most other states provide this service for a nominal charge.

Routine soil tests should be made on turf areas at regular intervals. In a new situation where you are not familiar with the fertility status of the turf areas being managed, the soil should be sampled immediately and at the same season a year later. Once the general fertility status of a soil is known the following schedule of soil testing should be adequate to guide you in increasing or decreasing the amounts of lime, phosphorus and potassium to use.

Table 6. A suggested schedule for soil testing turf areas [1/]

Kind of Turf	Frequency of Testing
Putting greens	Every 2 years
Tees and Athletic Fields	Every 3 years
Lawns, Fairways and General Turf	Every 4 years
Roadsides and Airstrips	Every 5 years

[1/] When possible take samples at the same season of year and avoid sampling immediately after applying fertilizers or other chemicals.

Where clippings are removed and/or irrigation is used the amount of fertilizer needed will be increased. This explains in part why fairways need less nitrogen than putting greens which generally receive more irrigation and from which the clippings are removed.

Traffic Influences Fertilizer Requirements of Turf:

The "wear and tear" of heavy foot and vehicle traffic increases the difficulty of growing turf by a factor of great magnitude. For example, it is easy to maintain grass on a teeing area which receives little traffic. That is why golf course superintendents who have "light play" can't understand the complaints of the superintendent whose course has 200-300 rounds per day.

Proper use of nitrogen fertilizers can be the salvation of turf areas subjected to heavy traffic. Worn and damaged turf can only be restored by the growth of new leaves. And new leaves, like new tissue in animals, are rich in protein--a substance rich in nitrogen. Turf well supplied with nitrogen can withstand many times more traffic than nitrogen deficient turf. Areas of turf subject to "heavy" traffic should be supplied with up to twice the normal rates of nitrogen fertilizer. These areas include par 3-tees and grassed cart paths on the golf course; Margins of base paths, dugouts, and the bull pen areas in baseball stadiums; Picnic areas in parks and parade grounds on military bases to name but a few.

In traffic studies on bermudagrass and zoysiagrass at Mississippi State University we have found these species able to withstand more than 100 golf shoe spikes/per sq. ft. daily if given 1 1/2 lbs. of N/1000 sq. ft. monthly. But foot traffic leaving 50 spikes/sq. ft. per day denuded these grasses where only 1/2 lb. of nitrogen was applied.

Nitrogen hastens the healing of divot injury on tees and fairways. The data in Table 7 show the influence of nitrogen on the recovery of "Tifway" bermudagrass from divot injury. These data clearly emphasize that turf damaged by traffic or mechanical causes should be given added amounts of nitrogen to hasten full recovery.

Table 7. Recovery of Tifway bermudagrass from divot injury.

Nitrogen [1] lbs./1000 sq. ft.	Mowing Height	Percent cover				
		Weeks after injury				
		3	4	5	6	7
4	1/2 in.	19	25	41	48	96
8	1/2 in.	35	44	77	89	99
4	1 in.	26	31	58	61	98
8	1 in.	43	49	80	94	99

[1] Nitrogen applied at 1 and 2 lbs. per month during warm season. Divots 8" long were made with golfing wedge. Unpublished data. C. Y. Ward.

Turf Quality Desired and Use Influence Nitrogen Needed

Golf putting greens represent the ultimate in turf quality. Because of frequent irrigation, clipping removal, heavy foot traffic and partial and mechanical denuding to control thatch, golf greens require more nitrogen than fairways and tees. This is true even where the same variety of bermudagrass is used for the entire course. As shown in Table 4, bermudagrass quality is adequate for lawn turf when 6 lbs. of nitrogen are applied annually, but 10 and 20 lbs. may be required for tees and greens, respectively. The increased need for nitrogen for tees and greens is related to the increase in mowing frequency, traffic and watering. Football playing fields are another critical use area. A moderate rate of nitrogen may be adequate as a base rate to impart the desired green color and turf density. This amount of nitrogen applied at 1 lb./1000 sq. ft. monthly during the growing season is adequate for light traffic. But, 2 lbs. monthly or even more will be needed on the heavily played areas in the center of the field. Practice fields may need more fertilizer that the stadium field. One thing is certain--a well-fertilized turf reduces player injuries and improves the image of the turf profession.

Fertilization at Establishment Time

Incorporating fertilizer in the root zone prior to establishing turf is good insurance against stand failure. Even on very fertile soils some fertilizer should be incorporated in the seed bed prior to planting. It is especially important to get phosphorus incorporated into the seed bed as it does not move into the soil like nitrogen and potassium when applied to the surface. A good rule of thumb is to incorporate 3-4 lbs. of nitrogen, and 4 to 6 lbs. of potassium (K_2O) and phosphorus (P_2O_5) per 1000 sq. ft. prior to seeding or stolonizing.

When establishing warm season grasses vegetatively (sprigs, stolons, plugs) the rate of spread can be enhanced after planting by applying 1/2 to 1 lb. of nitrogen every 1 to 2 weeks for the first 8 to 12 weeks or until coverage is complete. Then follow the fertilizer program for regular maintenance.

ARE MINOR ELEMENTS IMPORTANT IN TURF?

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Minor elements become important in plants after their need for major elements has been satisfied. In other words, first priority is to supply the major nutrient elements. A deficiency in a major nutrient element is likely to mask over any minor element deficiency.

There are 16 nutrient elements which are essential to plant growth. They may be divided into the following catagorization:

Major		Minor		
From air and water	From the Soil	Secondary	Micronutrient	
C=carbon	N=nitrogen	Ca=calcium	Zn=zinc	B=boron
H=hydrogen	P=phosphorus	Mg=magnesium	Fe=iron	Mo=molybdenum
O=oxygen	K=potassium	S=sulfur	Mn=manganese	Cl=chlorine
			Cu=copper	

The basis on which these essential plant nutrients are grouped is according to the relative quantities needed by the plants. The micronutrients, or trace elements as they have been called in the past, generally occur in very small quantities in most soils. The secondary elements occur in the soil in amounts somewhat intermediate between the micro- and major nutrient elements. A similar sequence is also generally found within the plant tissues as shown in the following table:

The relative ratio of essential mineral nutrients found in plants. (after Stout)

Mo	1	P	30,000
Cu	100	Mg	variable
Zn	300	K	400,000
Mn	1,000	Ca	variable
Fe	2,000	N	1,000,000
B	2,000	H	variable
Cl	3,000	O	variable
S	30,000	C	30,000,000

The relative ratio of nutrient elements in plants indicate that molybdenum is present in least amount. For each molybdenum molecule there are approximately 100 molecules of copper, 300 of zinc, etc.

Although the micronutrient elements are required only in trace quantities, this is not to infer that they are only of small importance. A deficiency of one of the micronutrients can be just as detrimental on plant growth as a deficiency of a major nutrient element. The difference is that such a small amount of fertilizer material can have such a large influence.

Availability of minor elements is affected by several factors, with soil pH being one of the most important. As shown in Figure 1, the greatest availability of the major (N, P, K) and secondary (Ca, Mg, S) nutrients occurs near a neutral pH range while micronutrient availability is generally favored by acid soil conditions.

Since the micronutrients are least available under high pH or alkaline soil conditions, one might expect their deficiencies to develop in alkaline soils. This is generally the situation. Micronutrient deficiencies are observed most frequently in alkaline soil areas. Heavy liming of acid soils tends to initiate micronutrient deficients. Although liming is one of the most practical sources of supplying the secondary elements calcium and magnesium, the increase in pH and calcium carbonate from it may cause a decrease in the availability of the micronutrients.

Soils which are too acid to facilitate good root growth may need to be limed. Should liming indirectly cause micronutrient deficiencies in the manner mentioned above, then those nutrients becoming deficient may need to be applied. In alkaline soils where micronutrient deficiencies occur, it is generally more economically feasible to supply the needed nutrients than to attempt to lower the pH by addition of soil amendments and thus enhance availability.

Promiscious use of fertilizers could induce serious nutritional imbalances which in turn could cause fertility problems which would be difficult to remedy. Therefore, care should be exercised in applying balanced fertilizers containing those elements needed. One of the best tests to determine if a deficiency exists is to try a small amount on an area where a deficiency of the element is suspected. Either a foliar spray or soil application across a small test strip should respond within a week or two.

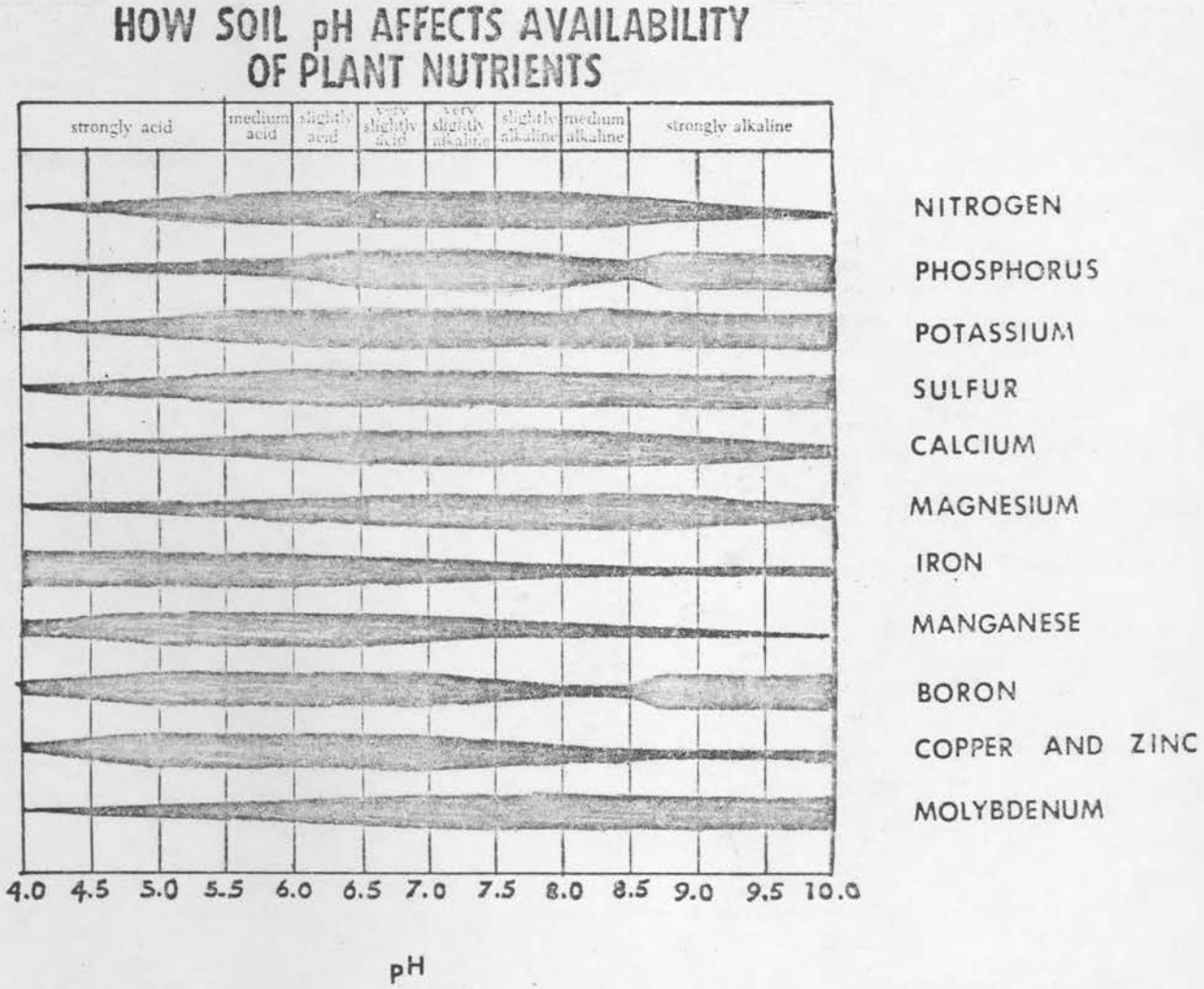

Figure 1. Effects of soil reaction on availability to plants of soil nutrients (after Truog). The width of the bar determines the relative availability of each element with a change in soil reaction.